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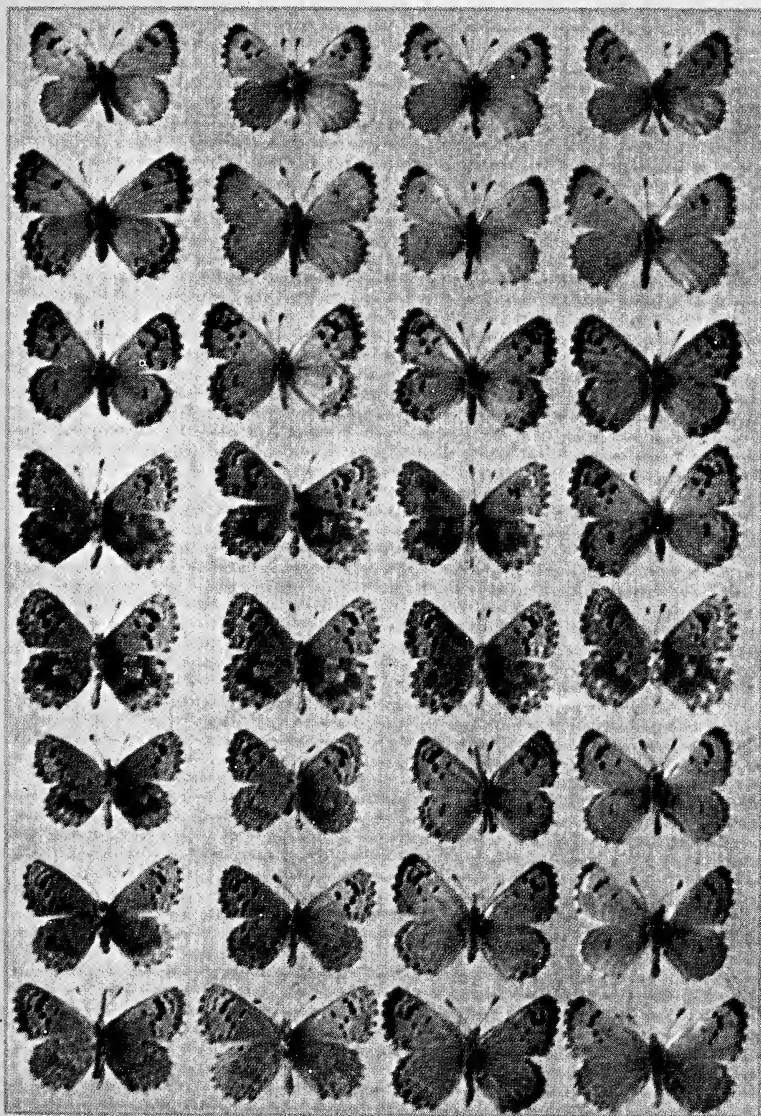
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THE PURPOSE OF THE JOURNAL is to combine in one source the work in this field for the aid of students of this group of insects in a way not at present available. THE JOURNAL will attempt to publish primarily only critical and complete papers of an analytical nature, though there will be a limited section devoted to shorter papers and notes. QUALITY WORK on any aspects of research on the Lepidoptera is invited. Analytical and well illustrated works are preferred, with a minimum of long description.

AUTHORS ARE REQUESTED to refer to the journal as an example of the form to be used in preparing their manuscripts. Illustrations should be of the best quality black and white, or line drawings and should be pre-arranged by the author to fit a reduced size of 4" x 6½." Footnotes should be avoided; bibliography should be as indicated. Tables should be set-up for page size as indicated. Manuscripts in good form and requiring little work by the editor will naturally appear first. Authors, who wish drawings made for them, may submit rough sketches and will be billed for the cost, which will be very negligible. Work to be done on research grants should so specify. When possible, tabular matter should be typed on good paper with a carbon ribbon in a form suitable for a one-third reduction and in a size to fit 4" x 6½."

THE JOURNAL is not a suitable place for continued changes of nomenclature; unless the author is himself analytically studying a group from its biological point of view and finds a change necessary, the editor must ask authors to refrain from any changes from the McDunnough Check List unless superseded by a monograph published since that date. Popular books are not to be considered as giving scientific credence to any name. It is rare that name changes need be made and preference is given to old names unless in the editor's opinion sufficient evidence is given to warrant such change.

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THE EFFECTS OF pH ON THE DISTRIBUTION OF THE MEGATHYIMIDAE

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FROM MY FIRST CAPTURE of a member of the Megathymidae (a specimen of *Megathymus yuccae stallingsi* Freeman) at Vickery, Texas, April 12, 1938, a keen interest was developed in this group of butterflies. The close association of the Megathymidae with their host plants, *Agave*, *Yucca* and *Manfreda*, has led to the study of some very interesting habitats. At first, it was a matter of locating the adults on the wing and of trying to catch them with a net. That, however, was difficult and often resulted in damage to the specimen and sometimes to the collector. As knowledge about the life histories of the various species developed, techniques were devised for collecting the larvae and pupae. The net was then put aside and in its place such equipment as a fox hole pick, bayonet, and drain spade took its place. Records of the distribution of the various species of *Agave*, *Yucca*, and *Manfreda* were studied and from this information, various collecting trips were made which resulted in the discovery of many interesting new species of Megathymidae. It was thought provoking that a perfectly fine stand of *Yucca* did not always result in the finding of a colony of *Megathymus*, whereas within a short distance a much less favorable-looking area would have plants attacked by the larvae. Now, it is known that there are several factors in the environment that govern the survival of a colony of these insects in a given habitat. One particular factor, the pH of the soil, attracted attention about six years ago and since that time soil samples have been carefully checked from all of the study habitats under consideration. The knowledge so obtained explains in part why success has not always been had in locating larvae in apparently fine stands of both *Yucca* and *Agave*.

I would like to express my appreciation to the National Science Foundation for Research Grant CB-398 which is making my studies of the Megathymidae possible.

Along with Stallings and Turner, a rather extensive study of *Agathymus mariae* (B. & B.) and its related species has been made. In carrying on this present study, 33 locations were selected by the author; these extend from El Paso and Carlsbad National Park to Boquillas Canyon, and to the north of Bracketville, Texas, where *Agave lecheguilla* Torr. occurs. At each location, the following factors were checked, pH of the soil, type of soil, elevation, plant associates, average annual rainfall, and presence or absence of radiation with Geiger counter. The most significant factor seemed to be the pH of the soil. It was found that *Agathymus mariae* occurred where ever the pH ranged from 7.3-8.9, with the average being slightly below 8, indicating that it is best suited to live where the soil is alkaline. In the southeastern section of the study habitats, the pH was around 7, indicating neutral soil; *mariae* was not found in these areas, but instead *Agathymus estelleae* (Stallings & Turner) and three new species (that are now in the process of being named) were found.

The following data has been found on the other species of *Agathymus* that occur in Texas. *Agathymus florenceae* (Stallings & Turner) occurs where the pH of the soil ranges from 5.9-6.1, *A. carlsbadensis* (Stallings & Turner) around 7.9, *A. judithae* (Stallings & Turner) around 7.3, *A. diabloensis* Freeman around 7.4, *A. mcalpinei* (Freeman) around 7.4-7.6, *A. chisosensis* (Freeman) around 5.2. The last indicates the strongest acid soil relationship.

In Arizona it was found that *Agathymus aryxna* (Dyar) is associated with soil where the pH ranges from 5.3-6.1, and *A. polingi* (Skinner) from 5.8-6.1.

In Texas, there are several subspecies of what are now called *Megathymus yuccae* (Bdv. & LeC.). It has been very interesting to see how the pH of the soil is related to the distribution of these subspecies. The first subspecies studied, *stallingsi* Freeman, occurs from north central Texas, Oklahoma to Caldwell, Kansas. In Texas, it is associated with limestone outcroppings where the pH is usually just under 8. East of the Dallas area, there is a distance of about seventy miles where the soil changes from alkaline, through neutral to distinctly acid. In the neutral area, no colonies of *Megathymus* have so far been located even though there are fine stands of *Yucca* present. At Canton, Ben Wheeler and Tyler State Park, the soil ranges from pH 4.9-5.1. In this area a different subspecies is found which was recently named

reinthalii Freeman. This is a sandy soil subspecies associated with pines and oaks. In the Rio Grande Valley, the subspecies *wilsonorum* S. & T. is associated with sandy soil and scrub bushes but the soil ranges from pH 7.4-7.8. In the Del Rio area, the subspecies *louiseae* Freeman is found. Here, the pH is very near pH 7, indicating a neutral soil relationship. In the extreme western part of Texas, the subspecies *reubeni* S., T. & S. is found in the Hueco mountains where the soil is alkaline, ranging from pH 7.3-7.6. Another subspecies (not yet named) was found in western Texas where the soil was very sandy and the pH was acid, averaging pH 5.

Other *Megathymus* records for Texas indicate the following results. In areas where *Megathymus texanus* B. and McD. have been collected, the pH ranges from 7.-7.6. At and near the type locality of *Megathymus violae* S. and T. the pH was 7.5. In the Big Bend National Park, where *M. violae* is found the pH is 7.4.

In the Tucson, Arizona vicinity, where the pupae of *Megathymus ursus* Poling were collected by myself the pH ran from 5.8-6.

During August 1962, in association with the Stallings, a study was made of 22 selected habitats in north central Mexico, extending from General Bravo down through Victoria to Antiquo Morelos, up through Saltillo, over to Torreon and then through Monclova to Allende. It was found that *wilsonorum* from near China occurred in areas where the pH was identical to its habitat in the Rio Grande Valley. The specimens collected of a *violae*-like species from El Tepeyac were associated with very dusty soil that had a pH of 6.1. *Agathymus estelleae* was found at several locations and the pH of those areas varied from 6.9-7.3. *Agathymus remingtoni* (S. and T.) was collected in areas where the pH was 5.-5.5. *Aegiale hesperiaris* (Walker) was found where the pH was 6.9-7. *Agathymus micheneri* S., T. and S. was found where it was 7. There are several species involved in the *mariae* complex from various locations studied. All were found where the pH was on the alkaline side of the range or nearly neutral and never where the soil was acid. There were other species involved in this study; however, until their exact status is determined I will omit them from this discussion.

No correlation was established between the presence or absence of certain species in a given environment due to radiation effects, because none of the areas studied showed to any pronounced degree the presence of radioactive particles.

The elevation of colonies was important to some extent in most species studied because the presence or absence of the host plants was correlated with elevation. Together with this was an indication of the presence of other plant associates. Correlation with type of soil appeared to be in direct relationship to the pH in most instances. The average rainfall seemed to have less to do with the presence or absence of certain species of Megathymidae than was previously thought. It was observed that west of Saltillo towards Torreon, the *Agave lecheguilla* were yellow or brown due to aridity yet the larvae of various *Agathymus* were present in the plants in more or less large numbers.

From all the data collected over the past six years, the opinion has been drawn that the pH of the soil is one of the most important factors governing the distribution of various species and subspecies of the Megathymidae, and in the selection of host plants. A listing of food plants of this group of insects together with the pH of the soil where found is given in Freeman (1963).

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DECAPITATION-INITIATED OVIPOSITION IN CRAMBID MOTHS

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THE MEAGER LITERATURE on decapitation-initiated oviposition in insects has been partially reviewed by Chiang and Kim (1962) who observed the phenomenon in crane flies. M'Cracken (1907) had previously shown that mated female silkworm moths exhibit an early oviposition response to abdominal stroking when decapitated; however spontaneous egg production was rare following head removal.

It has been observed in a number of instances that certain insects tend to oviposit in response to being trapped or wounded (Harwood, personal communication, 1963), yet there is little doubt that an inhibitory center in the subesophageal ganglion does exert a controlling effect on oviposition (Roeder, 1963). An opportunity to study the behavior of certain microlepidoptera with regard to the inhibitory role presumably played by this ganglion over endogenous oviposition activity recently presented itself; the following being a report of some preliminary work suggesting areas where the nature of the control could be more fully explored.

In a study of the reproductive biology of lawn moths in the family Crambidae it was found that decapitation of gravid females brought about oviposition generally within ten minutes for fall-generation *Crambus bonifatellus* Hlst. and *Euchromius californicalis* (Pack.), the two species then available. Tactile stimulation following decapitation was not necessary to induce egg deposition. Decapitation was performed with a pair of fine scissors after moths had been cooled to sluggishness. Immediately following the operation the headless moths stood quietly, and shortly thereafter the terminal part of the abdomen began to undergo rhythmic contractions which continued during oviposition. In some cases the entire abdomen vibrated in a vertical plane as well. Decapitated male moths also exhibited

abdominal contractions and periodically expanded their genitalia. Moths of both sexes showed no tendency to mate when held together in different positions after decapitation. The effects on oviposition activity of inflicting gross injury without damaging the subesophageal ganglion or nerve cord have not yet been investigated.

The time interval between head separation and oviposition proved variable for *C. bonifatellus*, the most abundant crambid and the only one used experimentally. Under room conditions, individuals of a group of ten females caught at light took from 50 seconds to nine and a half minutes to begin laying eggs after the operation. Directly after beginning to lay, these moths were dissected and subsequently divided into three classes according to the relative amount of eggs and fat body in the abdominal cavity. Since there was an obvious lack of correlation between abdominal class and time intervals concerned, it would appear that within about ten minutes after decapitation any mechanical pressure responsible for moving eggs out of the reproductive tract is not a direct function of the degree of gravidness.

In order to determine whether the circadian oviposition rhythms known to occur in these species (unpublished data) are maintained by headless moths, a number of decapitated *C. bonifatellus* females were exposed to darkness at $28.0 \pm 1.4^{\circ}\text{C}$ and their eggs collected in a manner previously described (Crawford, 1962). The resulting oviposition was sporadic, and though eggs were generally laid in batches, there was no semblance of the usual diurnal rhythm. This result is consistent with Harker's (1955) finding that subesophageal gland neurosecretory cells are responsible for activity rhythms in the American cockroach, *Periplaneta americana* L. It is therefore to be expected that successful subesophageal gland implantation into headless crambid females may re-establish the rhythm.

The decapitated crane flies used by Chiang and Kim (1962) laid a greater percentage of fertile eggs than did controls, though it was not indicated whether this difference was statistically significant. In the present study crambid eggs were also tested to see if egg fertility was affected by decapitation. Twenty moths obtained from light (and therefore of unknown age) were cooled for at least 24 hours at about 5°C , then half of these were decapitated while cold. The other ten were used as controls. All moths were incubated at $28.6 \pm 2.5^{\circ}\text{C}$ in petri dishes at the

bottom of which were moist circular pieces of blotting paper. Decapitated females were not as physically active as controls, and remained alive (in the sense that they were capable of body movement) an average of 3.9 ± 0.5 days, which was not significantly different from the 5.1 ± 0.5 days lived by controls. No records were kept of daily oviposition by individuals, but it was obvious that some decapitated moths laid for at least 48 hours. In calculating final percentages of fertility, eggs which remained yellow or slightly pink a week after being laid were considered infertile, while eggs obviously about to hatch but in danger of being eaten by cannibalistic larvae were considered fertile.

Out of a total of 506 eggs laid by headless moths 11.1% were infertile, while 22.6% of the 974 control eggs were infertile. A chi square analysis of the pooled experimental data using controls as standard indicated the difference in fertility was highly significant ($X^2 = 52.28$, 1 d.f.) However a chi square analysis of heterogeneity (Snedecor, 1956) which was prompted by obvious differences in egg fertility among individuals was also significantly high ($X^2 = 93.91$, 8 d.f.) The data therefore suggest that while decapitation may have had a positive effect on fertility, it would take a decidedly larger number of moths to show clearly that this is true.

ACKNOWLEDGEMENTS

The author wishes to thank Dr. Q. D. Clarkson, Portland State College, and Dr. R. F. Harwood, Washington State University, for critical advice given during preparation of the manuscript. For his assistance in obtaining specimens Mr. Peter F. Murray is also cordially thanked.

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Book Review

INTRODUCTION TO COMPARATIVE ENTOMOLOGY

Richard M. Fox and Jean Walker Fox
Reinhold Publishing Corporation, New York
i - xiv, 1-450, one color plate, numerous illustrations. \$9.50.

This book has been designed primarily as a textbook for an elementary course in entomology. However, the reviewer finds it an excellent reference source, especially for the study of the comparative anatomy and morphology of insects.

Unlike many standard entomology texts in which the classification of insects is the central theme, the Foxes have brought to this book a new approach. The general insect structural plan, and its deviations comprise the first two thirds of the book while classification is the last one third. The first eight chapters cover in order the skeleton, the appendages, the wings, maintenance systems (gut, circulation, respiration and reproduction), control systems (nervous, sensory and endocrine systems), early embryogenesis and postovarian embryogenesis. These subjects are covered in a masterful way, not duplicated by any other text, and long needed. The remaining five chapters cover comparative classification of the Arthropoda in such a way that a student can grasp the origin of insects from more primitive groups. There are chapters on Arachnids and Myriapods. The final chapter presents a comparison of the orders of insects, and some of the major families.

The reader should not obtain this book if he wishes an identification manual. It has not been designed for this purpose. He will find here however a well organized, truly comparative insight into the insect structure. There will be found little on insect ecology, habits, physiology, genetics, geographical distribution or fossil record. But one book cannot be everything to everybody.

In physical appearance, the book is put up very neatly and has excellent illustrations.

The Editor

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LIFE HISTORY STUDIES ON MEXICAN BUTTERFLIES

I. NOTES ON THE EARLY STAGES OF FOUR PAPILIONIDS FROM CATEMACO, VERACRUZ

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DURING THE SUMMER OF 1962, while engaged in collecting butterflies near Catemaco in the Tuxtla Mountains of southern Veracruz, Mexico, I was able to rear the immature stages of four species of the family Papilionidae: *Graphium belesis* (Bates), *G. epidaus epidaus* (Doubleday, Westwood & Hewitson), *Papilio androgeus epidaurus* Godman & Salvin, and *P. anchisiades idaeus* Fabricius. References to the immature stages of these are scanty and not readily available. Recent illustrative works, therefore, are of interest and benefit to students of the Lepidoptera.

Scale lines in all photographs represent .5 inch or 127 millimeters. All measurements are based on living material.

GRAPHIUM BELESIS Bates

The only reference made to the immature stages of this butterfly, to my knowledge, is a brief description of a mature larva (Dyar, 1912). The present photographs represent the first published illustrative material.

EGG. (Description based on 2 eggs.) Duration of stage, 4 days (74°-90° F. ambient temperature). The egg is a sphere having a diameter of 1.0 mm. and being light yellow in color. Superficially, it appears perfectly smooth but upon close examination, tiny facets or reticulations could be discerned. Eggs are attached to the undersurfaces of the leaves of *Annona muricata* L. (Annonaceae) called "Guanabana" by the local residents. A related species, *A. reticulata*, grew in the same vicinity, but females never seemed to be attracted to it.

FIRST INSTAR LARVA: Fig. 2A. (Measurements based upon one larva.) Beginning of stadium-length, 1.7 mm.; greatest width, 1.0 mm.; head diameter, .9 mm.

Head black with tiny, fine setae.

Body expanded anteriorly into a "false head"; color velvety black with a white transverse band (saddle) on sections of fourth and fifth abdominal segments. Legs and prolegs concolorous with body. Osmateria yellow-orange in color.

Second instar larvae similar.

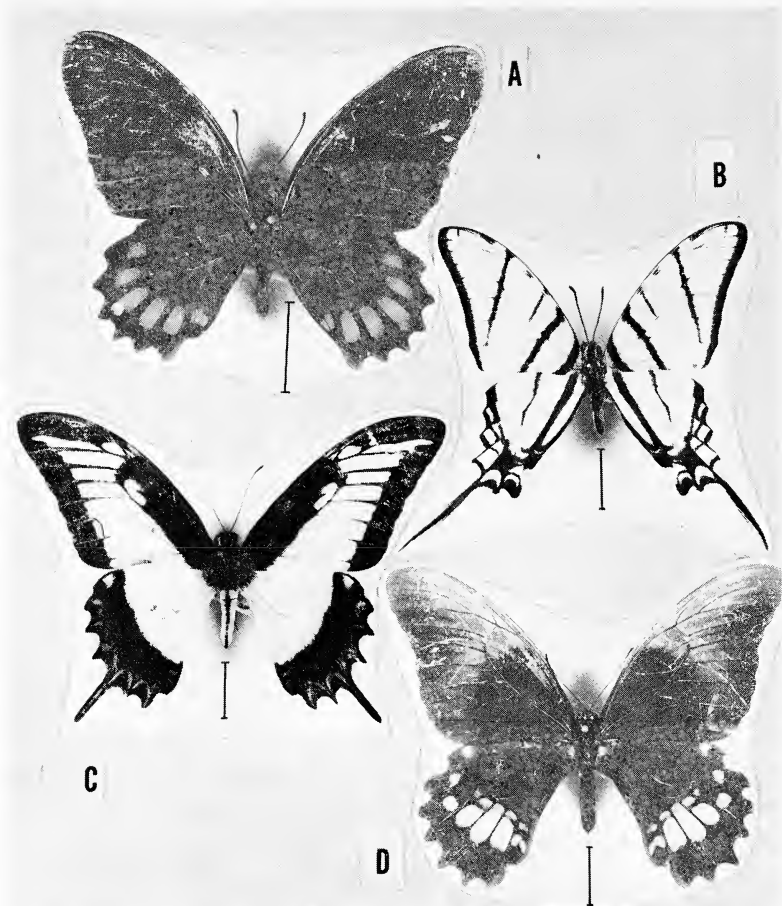


Fig. 1. Adults. A. *Graphium belesis* (Bates). B. *Graphium epidaus epidaus* (Doubt., Westw. & Hew.). C. *Papilio androgeus epidaurus* God. & Sal. D. *Papilio anchisiades idaeus* Fabr. Photographs by J. H. Roberts.

LAST INSTAR LARVA: Figs. 2B & C. (Measurements based on two specimens.) Beginning of stadium-length, 21.1-21.4 mm.; width, 9.0-9.2 mm.; head diameter, 4.1 mm. Termination of stadium-length, 32.1-34.2 mm.; width, 10.9-12.0 mm.

Head as before.

Body with anterior portion slightly less expanded than before. Color black with an irregular transverse white band (saddle) occupying major portions of fourth and fifth abdominal segments dorsally but only fifth segment laterally. Segments with longitudinal rows of smooth, dull red, paired tubercles: first and second thoracic segments with 1 lateral and 1 suprastigmatal pair; third thoracic and all abdominal segments with 1 subdorsal, 1 lateral, and 1 suprastigmatal pair. Legs and prolegs as before. Osmateria more orange.

PUPA: Figs. 4A & B. (Measurements based on one specimen.) Length, 20.0 mm.; greatest width, 11.1 mm. Duration of stage, 13 days.

The pupa of this species represents quite an interesting form (figs. 4A & B). Color a light, uniform green (slightly lighter on the "belly" portion). Four longitudinal rows of tubercles, also light green but slightly darker than the surrounding areas. Head portion with a ventral projection or "snout" 5.0 mm. in length. Girdle around constricted thoracic portion.

Adults (fig. 1A) were numerous around the edges of the secondary forests bordering Laguna Catemaco. The range of this species according to Hoffman (1940) is the warm regions of the eastern Sierra, Chiapas, and the southern and western Sierra as far as Colima and Jalisco.

GRAPHIUM EPIDAUUS EPIDAUUS (Doubleday, Westwood & Hewitson)

Immature stages (second and sixth instars and pupae) of the western subspecies *tepicus* Rothschild & Jordan, have been pictured by Comstock & Vazquez (1960). I observed no significant deviation from their illustrations in the eastern subspecies *epidauus*. However, I include it here because of the taxonomic difference and because of a difference in duration of the pupal stage.

EGG. (Comparisons based on 5 eggs.) Eggs are attached to the undersurfaces of the leaves of *Annona reticulata* L. (Annonaceae). As with *G. belesis*, females never were seen to oviposit on the related *A. muricata*.

LARVA. (Comparisons based on 11 larvae.) All instar larvae showed no deviation from the descriptions of Comstock & Vazquez (1960) for *tepicus*. A fifth instar larva is pictured in figures 3A & B.

PUPA. Figs. 4C & D. (Measurements based on 4 specimens.) Length, 26.1-26.5 mm.; greatest width, 10.3-10.6 mm. Duration of stage, 201 days. No deviation from *tepicus* was apparent. However, duration of pupal stage is quite different. Comstock & Vazquez state that the adults of *tepicus* emerged nine days after pupation whereas four *epidauus* imagos reared did not emerge from the chrysalids for 201 days. It should be mentioned here that my *epidauus* larvae pupated during early August, almost the exact time as the *tepicus* larvae of Comstock & Vazquez. However, these chrysalids were under natural (field) conditions for only 3½ months of the total time since I departed Mexico in early December of the same year and carried the pupae with me back to Louisiana. Then on a morning late in March, after having been exposed to laboratory conditions (about 28°C.) for nearly 3 months, 3 adults emerged. The following day, the fourth adult emerged. It seems reasonable to conclude that the larvae which I reared were representatives of the final brood of the year (after late August, no adults were seen in the field). It is likely that the eastern subspecies *epidauus* found in Veracruz undergoes a pupal diapause through the period of heaviest rains (September-January) and emerges as an adult after drier weather begins (February or March). To be sure, half of the time my pupae were under artificial conditions. However, I believe that the 3½ month diapause under natural, field conditions is justification for the above suggestion. Since Comstock & Vazquez did not report any diapause in *tepicus*, I assume that it either undergoes no diapause or else diapause begins at a later date than mid or late August.

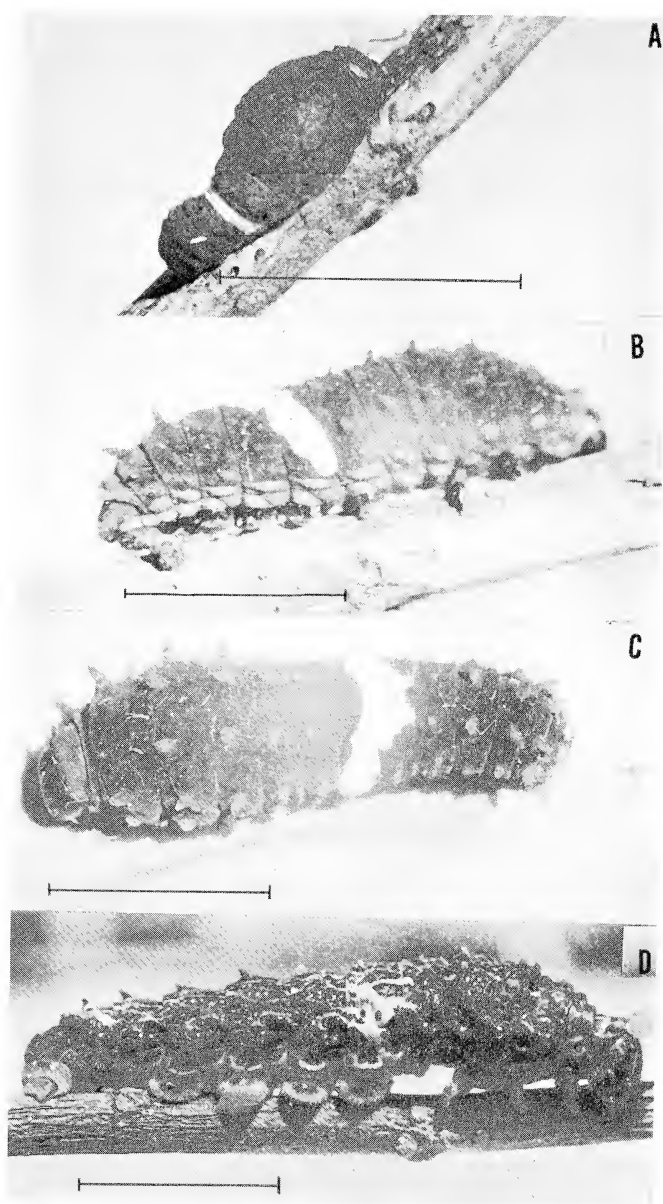


Fig. 2. Larvae. A. *G. belesis*, first instar. B. *G. belesis* last instar (lateral view). C. *G. belesis*, last instar (dorsal view). D. *P. anchisiades idaeus*, last instar. Photographs by R. F. Andrie.

Adults (fig. 1B) were fairly abundant in the general vicinity of the town of Catemaco during the months of April-August. After August, no individuals were observed. The range of the nominate species (Hoffman, 1940) is Veracruz, Tabasco, northern Chiapas, Campeche, and Yucatan.

PAPILIO ANDROGEUS EPIDAURUS Godman & Salvin

Four authors, Merian (1705), Moss (1919), Sepp (1855), and Burmeister (1879) have mentioned the immature stages of this species.

SECOND INSTAR LARVA (probably). Fig. 3C. (Measurements based on 3 specimens.) Beginning of stadium-length, 7.2-7.6 mm.; greatest width, 1.5-1.6 mm.; head diameter, 1.3 mm. Termination of stadium-length, 16.1-16.7 mm.; width, 3.2-3.4 mm. Duration, 5 days.

Head tan with numerous tiny, fine setae.

Body expanded anteriorly into a false head. Segments with rows of paired bristly tubercles: first thoracic segment with 1 reduced subdorsal, 1 prominent supralateral, and 2 less prominent pairs (1 lateral and 1 sublateral); second third thoracic segments similar but with supralateral pair reduced; abdominal segments as above but with lateral and sublateral pairs nearly indistinguishable. Color glossy tan-brown with a slight cream mottling; also, a cream colored saddle on the third and fourth abdominal segments, and an extensive creamy area on the last three segments. Legs and prolegs tan. Osmateria light orange.

LAST INSTAR LARVA. Fig. 3D. (Measurements based on 3 specimens.) Beginning of stadium-length, 41.1-43.5 mm.; width, 6.9-7.9 mm.; head diameter, 3.9 mm. Termination of stadium-length, 74.0-75.9 mm.; width, 19.1-19.7 mm.

Head as before.

Tubercles on all segments reduced to slight knobs with basal crescent shaped blue markings. Ground color dark grey to black; numerous white streaks and blotches (the latter being particularly extensive on the lateral sections of all thoracic segments and second-fourth and seventh-ninth abdominal segments). Legs and prolegs dark brown. Osmateria orange.

PUPA. Fig. 5B. (Measurements based on 3 specimens.) Length, 42.1-42.6 mm.; greatest width, 7.2-7.3 mm. Duration of stage, 51 days (only 1 adult emerged, the 2 other pupae having died).

Color dark brown with creamy, longitudinal lines and bands; also, a slight green shading on the wing cases. Head portion with three horn-like projections directed anteriorly. Girdle around non-constricted thoracic section.

Larvae were found resting on the upper surfaces of the leaves of *Zanthoxylum elephantiasis* Macf. (Rutaceae). To my knowledge, this is the first mention of this tree being the larval food plant of *P. androgeus*.

Adults (fig. 1C) were not common in the Tuxtlas. Only two individuals were seen and captured around the lake where the food plant was abundant along the margins of fields; two individuals were seen "hill-topping" above the peak of Volcán San Martín (5400 ft.) and one individual was seen engaged in the same activity above the peak of Cerro Tuxtla (2700 ft.).

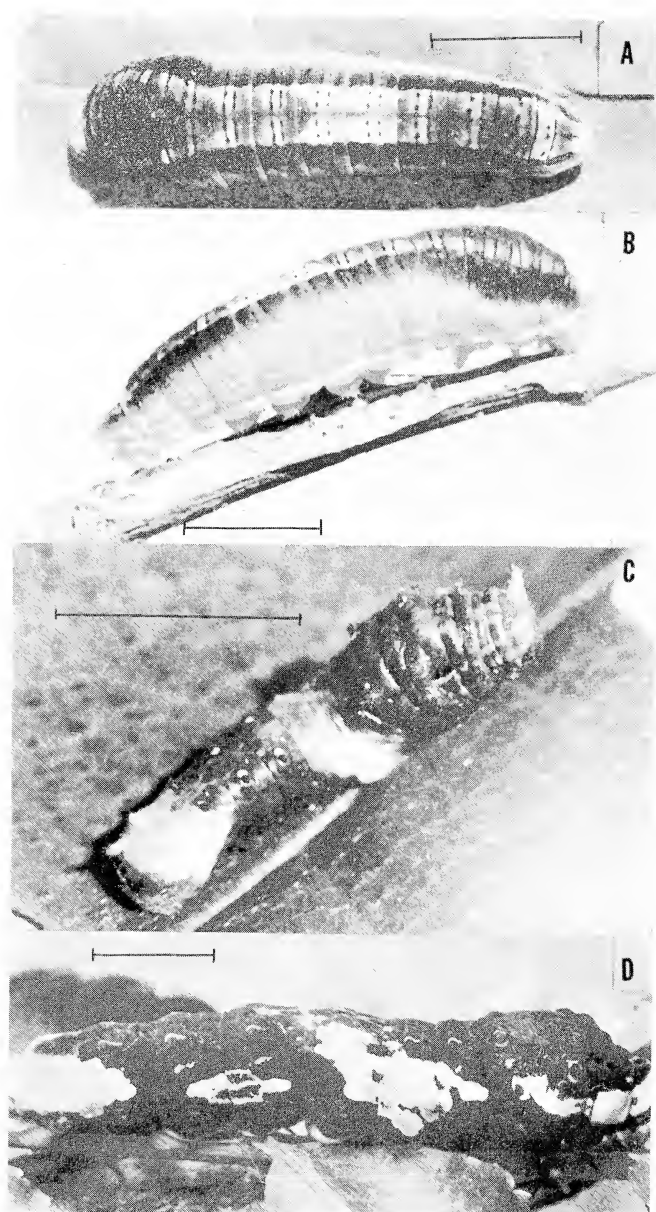


Fig. 3. Larvae. A. *G. e. epidaus*, fifth instar (dorsal view). B. *G. e. epidaus*, fifth instar (lateral view). C. *P. androgeus epidaurus*, second instar. D. *P. androgeus epidaurus*, last instar. Photographs by R. F. Andrie.

The range of the species (Hoffman, 1940) is southern Tamaulipas southward and the western Sierra as far as Sinaloa and Durango.

PAPILIO ANCHISIADES IDAEUS Fabricius

The stages of *P. anchisiades* are probably the best known of any of the four species under consideration here. This is probably due, in part, to its wide distribution (see below). Bates (1861), Caracciolo (1891), Dewitz (1886), Jones (1883), Moss (1919) and Stoll (1781) have mentioned the various stages in the life history of this insect.

LAST INSTAR LARVA. Fig. 2D. (Measurements based on 5 larvae.) Beginning of stadium-length, 27.0-27.8 mm.; width, 6.1-6.8 mm.; head diameter, 3.9 mm. Termination of stadium-length, 42.2-43.9 mm.; width, 7.0-7.2 mm. Duration, 8 days.

Head medium brown with tiny tubercles and setae.

Body more or less cylindrical, only slightly expanded anteriorly. Segments with pairs of subdorsal, supralateral and lateral tubercles (as described under *P. androgeus*) bare and concolorous with ground color. Color greenish brown with numerous streaks, lines and flecks of white or cream. Legs and prolegs brown. Osmateria yellow.

Larvae are nocturnal feeders on lime (*Citrus* sp.). During the day-light hours they rest together in groups on the trunk or stems of the food plant.

PUPA. Fig. 5A. (Measurements based on 3 specimens.) Length, 34.1-35.0 mm.; greatest width, 10.2-10.4 mm. Duration of stage, 13 days.

Color light brown with light green mottling beginning on wing cases and terminating at cremaster, giving the chrysalid the appearance of having a lichen encrustation. Slight dorsal protrusion anteriorly. Tubercles still evident. Girdle around non-constricted thoracic portion.

Adults (fig. 1D) were common around the citrus groves bordering Laguna Catemaco. According to Hoffman (1940) the range of the species is the entire eastern area of Mexico. Ehrlich & Ehrlich (1961) list the range as "southern Brazil to Mexico and southern Texas."

ACKNOWLEDGEMENTS

I wish to express my appreciation to the following people: Mr. R. F. Andrie (Buffalo Museum of Natural Science, Buffalo, New York), Dr. J. H. Roberts (Louisiana State University, Baton Rouge, Louisiana), and Dr. S. M. Russell (Louisiana State University in New Orleans, New Orleans, Louisiana) for photographs and film processing; Dr. V. E. Rudd (U. S. National Museum, Smithsonian Institution, Washington, D. C.) for food plant identifications; Mr. K. H. Wilson (University of Kansas, Lawrence, Kansas) for specimen identifications and bibliographical citations; Mr. S. L. Warter, Dr. M. S. Blum and Dr. L. D. Newsom for suggestions regarding the manuscript and lastly, Christopher Andrie (Buffalo, New York) for help in assisting me with the larval rearings.

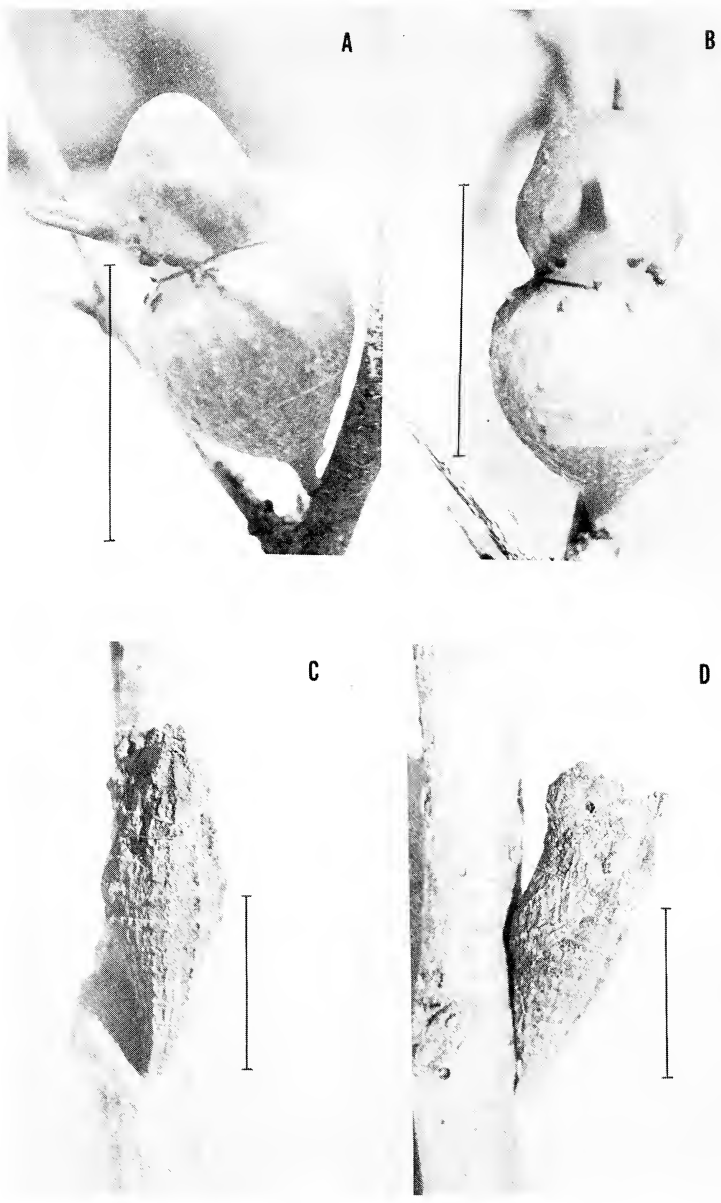


Fig. 4. Chrysalides. A. *G. belesis*, lateral view. B. *G. belesis*, ventral view. C. *G. e. epidaus*, ventral view. D. *G. e. epidaus*, lateral view. Photographs by R. F. Andrie.



Fig. 5. Chrysalides. A. *P. anchistades idaeus*. B. *P. androgeus epidaurus*. Photographs by R. F. Andrie.

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Book Review

A SYNONYMIC LIST OF THE NEARCTIC RHOPALOCERA

Cyril F. dos Passos

The Lepidopterists' Society, New Haven, Connecticut

i - v, 1 - 145, including index, \$ 4.50

This is the first list of Nearctic butterflies printed since 1938. As such, it is an excellent compendium of names because the meticulous care of the author, no doubt, insures that all names are included. An innovation for a checklist is the placing of the year of publication after a name.

An excellent retention is the list of infrasubspecific names. The reviewer does not believe that such names need or ought to be in Latin, but in view of the fact that most such names in butterflies were proposed as species, or 'varieties', they may be nomenclatorially valid: in addition, there is yet too much uncertainty as to the nomenclatorial position to which many names belong. For example, the name *hagenii*, is listed as a seasonal form under 286b as *Colias eurytheme keewaydin* whereas the reviewer uses this name as a subspecies of *Colias philodice*. The problem is that lists like this do not always represent the latest biological knowledge of the group in question. As used in the present list, the name *hagenii* is not valid, but as used by the reviewer, it is.

Dos Passos has done an excellent nomenclatorial job, but there are serious defects created by limited study of the biology of many groups of Nearctic butterflies. It has been shown that *C. harfordii* (289), *C. occidentalis* (290), *C. alexandra* (293), are subspecies of one species and that *C. barbara* (288) is most probably a seasonal form of one of these. Also, it has been shown that *C. interior* (291) and *C. pelidne* (294) are geographical or altitudinal counterparts of one species (thus, are subspecies). Other obvious problems arise with *Zerene eurydice* (298) and *Z. cesonia* (299), which are subspecies. *Pieris occidentalis* is a species distinct from *P. protodice* (277); *Oeneis ivalda* (662) is a subspecies of *O. chryxus* (665). *Limnitis arthemis* (516), *L. weidemeyerii* (519), *L. lorquini* (520) and probably *L. astyanax* (517) are geographical races of one species; many of the *Papilio*s (248-254) need detailed biological work for many of these are subspecies; *Plebejus icarioides* (458), *P. pardalis* (459), and *P. pheres* (460) are subspecies; *Melitaea gabbii* (574), *M. malcolmi* (575), *M. acastus* (576), *M. palla* (582) and possibly *M. neumogeni* (573) are subspecies; *Melitaea leanira* and *M. alma* are subspecies; the races of *Euphydryas chalcedona* (593), *E. anicia* (594) and *E. editha* (595) are badly mixed up as there are probably only two species here; *G. lygdamas* (479) and *G. xerces* (480) are one species. This list could grow and grow depending on the extent of one's knowledge. The information necessary to have put the names mentioned in a natural order has been published for all the above named, and no doubt for many others. It is unfortunate that the great efforts and the meticulous work of the author did not extend to the biological aspects of taxonomy, for a list of names such as this is intended to indicate phylogenetic relationships and it will be used as such. If it were not to be used in this way, no great catastrophe would be assumed.

Another deficiency in the present work is the failure to include a complete list of Nearctic generic names. This comes about by the expedient of using a recent name in North America (*Speyeria*) for a world wide genus (*Argynnis*) having an older established name. How many other times older names with priority have been omitted can only be conjectured; all our common generic names, *Papilio*, *Pieris*, *Colias*, *Melitaea*, *Vanessa*, *Parnassius*, etc., etc., could be eliminated from North America by the same procedure and will be in the future by "splitters". Names propounded by splitters do not have to be used merely because they have been proposed. Eventually, every species will be placed in a different genus by somebody; this is inevitable. The balance of perspective must not be lost and it is up to biologists in general to demand that we look at the forest, from a distance, not only at the trees.

It is hoped that this list will not be used as an inviolate text; the knowledge of phylogenetic relationships in the butterflies is advancing into a new level of excellence and taxonomic relationships are being brought up to date daily. Unlike the methods used in developing lists of the past, modern scientific methods of experiment and analysis are being used; the relationships shown by names should reflect such knowledge, or their purpose has been thwarted. To the end that dos Passos has produced an excellent and complete list of names, he is to be commended. Now, Lepidopterists owe it to him, and to science in general, to indicate by the study of relationships between populations, the natural arrangement in phylogeny of the insects designated by those names.

The Editor

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MELANIC TENDENCIES IN PHALAENID AND GEOMETRID MOTHS IN EASTERN PENNSYLVANIA

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ALTHOUGH INDUSTRIAL MELANISM has come to be a standard citation in the literature of genetics and evolution, relatively little has appeared in the United States on the subject. Few descriptions of melanics on this side of the Atlantic have found their way into print, nor have the few that have been remarked received much attention from the geneticists. This paper gives records of 15 species showing melanic tendencies in Pennsylvania, with frequency data for the commoner forms; several of these species have not been reported previously as having melanic forms. The evolutionary implications of the melanism are discussed following the enumeration of species.

GEOMETRIDAE

Several of the classic Palaearctic mutant melanics occur in this family, especially in the tribe Cleorini of the Ennominae, and the best-known of the American ones, namely *Amphidasys cognataria* Gue. and *Phigalia titea* Cram., are congeneric with Old World species having melanic forms (*A. betularia* L. and *P. pedaria* Fabr.). In *A. cognataria* the black form¹ (which is solidly black, without markings) is decidedly more frequent than the "normal" in eastern Pennsylvania. The species is very common and data are available for a number of localities, but too little is known of the movements of individuals and the characteristics of the population of this, as of most nocturnal moths, for a really meaningful analysis to be made of the variation in frequency of the melanic form noted from different (urban vs. rural) sampling stations. The over-all frequency of the melanic phenotype appears to be 60-65% of both sexes.

In the very abundant spring species, *P. titea*, the melanic form is less frequent than the "normal", but a marked rise in frequency has been observed in recent years in Pennsylvania. The increase was especially notable in March-April, 1963, in which season the species was also unusually abundant in general. As pointed out by Ford and others, unusual abundance of a species is as a rule accompanied by extraordinarily wide latitude in variation, and this was the case here. While the number of

total melanics exceeded 25% of the males for the first time at nearly all sampling stations, several partial melanics of previously unknown types also appeared. The usual melanic form as in *cognataria*, is solid black. The partial melanics were of two types: either black, with the submarginal band on all wings normal gray; or dark, uniform charcoal-gray, with the darker markings indistinctly visible above and beneath. Examples of all of these types are in the collection of the author. The frequency of total melanics in 1959-61 was 10-15%, and in 1962, ca. 18%.

Melanism occurs in a large number of Cleorini in Pennsylvania. Aside from these two common, well-known species, several of the less common forms have shown melanic tendencies. The distinctive *Epimecis virginaria* Cram. has developed both partial and complete melanism. The partial melanics are dark, brownish-gray, with the three principal lines of the wings unsuffused over their light edging (basad on the postbasal line, and marginad on the median and submarginal ones). The total melanic is solid black with the exception of these same three light lines, which are even more conspicuous on the black ground.² *E. virginaria* is uncommon at the latitude of Philadelphia and northward, but the black form seems to be occurring with considerable frequency, the combined values of the two dark types probably reaching at least 50% (of which at least 35% is "total"). One melanic specimen of *Paraphia subatomaria* Wood has been taken in Chestnut Hill, Philadelphia (28 July 1962); it and the related *P. unipuncta* Haw. are both uncommon to rare.

Another related species with melanic tendencies is the scarce *Nacophora quernaria* Ab. & Sm. This insect is too uncommon for any reliable frequency figure to be available for the melanic form in eastern Pennsylvania. Less than a dozen area specimens have been seen by the writer. The melanics³ have the ground-color full black, with the white edging of the postbasal and postmedian lines (basad and marginad, respectively) conspicuously unsuffused. No melanics have yet turned up in the rare spring species, *Lycia ursaria* Walk., but they may be expected.

Two more possible instances are found in the Cleorini, namely *Cleora pampinaria* Gue. and *Ectropis crepuscularia* L. Both of these common insects have a wide range of variation from very light to very dark gray forms. One fully black *pampinaria* was taken at Flourtown, Montgomery Co., Pa., 8 September 1963. A single melanic specimen of *crepuscularia* has been described.⁴ The writer has not seen any black Pennsylvania individuals of this species.

The important pest, *Palaeacrita vernata* Peck, is quite variable in color, and a good case for melanism can be made when the

darkest forms are compared with the lightest. No fully black individuals have been taken, and the character is apparently not so clear-cut as in other Cleorines. The darkest individuals seem to be more frequent in recent years than previously, however.

One more indisputable case of melanism in the Geometridae concerns a member of the Sterrhinae, *Cosymbia lumenaria* Gue. Two black specimens were taken in 1963 (Flourtown, 7 July; Conshohocken, 11 Aug., both Montgomery Co.), both with the discal spots and the postmedian line on all wings the usual pale gray, contrasting with the sooty ground-color. The species is rather uncommon in the area, and no frequency figure can really be given.

PHALAEINIDAE

The best-known species with melanistic tendencies in the Phalaenidae is *Charadra deridens* Gue. It is common and the frequency of the black forms in Pennsylvania is at least 50% and probably somewhat higher. Some of the melanics are solid black; most have the postmedian line white, and a few have the postbasal line white also. The second of these was described in 1923.⁵ All have the normal black markings faintly discernible. A few females seem to be intermediate between the "normal" and melanistic phases, being moderately suffused with black scales.⁶ Two scarce species contribute additional records. *Panthea furcilla* Pack. has a nearly melanistic form which is considerably darker than the typical form, but the dark markings remain visible. *Polia latex* Gue. has a black form, previously unrecorded, also with the dark markings still identifiable. Both are too uncommon for frequency figures to be available. Dark *furcilla* have been taken for several years in Philadelphia, and the first melanistic *latex* was taken at Conshohocken, Montgomery Co., 11 May 1963. One more possible case of melanism is *Marasmalus inficita* Walk., but the citation rests on but a single melanistic specimen (Norristown, Montgomery Co., 9 August 1961). The species is quite uncommon.

NOTODONTIDAE

Two Notodonts appear to have melanistic forms, namely *Cerura cinerea* Walk. and *Lophodonta ferruginea* Pack. Both appear to have a relatively high frequency, although the second species is generally much commoner than the first, and hence more readily analyzable. In both, the melanism is quite noticeable, although in *cinerea* it is a dark charcoal gray, not a black, form. The frequency in *ferruginea* has been about 60% for several years, indicating that, as in *A. cognataria*, the darker has become the statistically "normal" form.

In 1927 Chermock described melanics of *Heterocampa umbrata* Walk.⁷ and in 1929 of *Fentonia marthesia* Cram.,⁸ both

from Pittsburgh. Both species occur in the writer's sampling area, but no melanics have been found of either. One black specimen of *Schizura apicalis* G. & R. has been taken (Flourtown, Montgomery Co., 14 June 1963). The species is uncommon. A possible second melanic of the same species, in very poor condition, was taken 8 July, 1959 (Norristown).

DISCUSSION

There seems to be adequate evidence to support the notion that melanism is fully as widespread in America as in Europe. Of particular interest is the regularity with which melanism occurs in species having a certain facies in the "normal" type condition, i.e. silvery-gray moths with black markings or dusting, irrespective of family. It becomes possible to predict the occurrence of melanics in various species; the writer actually did predict that melanic *Cleora* would be found, a year before the first specimen known to him turned up. In several cases where melanism has not appeared within a species where it might be expected on the basis of wild-type coloration, a black sibling species exists instead; for example, *Tolyte velleda* Stoll and its dark sibling *laricis* Fitch (Lasiocampidae).

Many of these melanics seem to recur sporadically in widely separated localities. The evidence would suggest that the large number of apparently new melanics turned up by the author in recent years is not really unusual, but rather the result of more assiduous collecting. Many species which show melanism today have had melanic "aberrations" described in the past, mostly on the basis of single specimens, and the genetic continuity of some of these with present-day melanics in the same species is often dubious. The melanic form of *Phigalia titea* is perhaps the best documented, and seems to have arisen spontaneously in various parts of the range at various times, meeting with variable success in different localities. In at least some of the species concerned, the rate at which the mutation to "melanic" occurs must be fairly high. The more often a specific mutation occurs, the more likely it is that it will at one time or another occur in a situation or environment where it will be advantageous, or it least not deleterious. Under such circumstances it is likely to be preserved and propagated. It is specifically this fact that the orthogenecists have seized upon to support their inference of a "direction" or "purpose" in evolution. All we can say at present is that certain genes seem to show an instability (probably chemical), and that in the cases here considered, that instability leans in the direction of melanism.

Several of the lesser known of the examples cited have been found only quite recently, and in the absence of prior records it is impossible to state to what extent they have been present in the past, either genetically continuous with the current form or as a result of previous mutation of the same type. It is of some interest, however, to consider the future of any given melanic mutation which may be assumed to have just arisen *de novo*. Most "industrial" melanics whose genetics have been studied have proved to be unifactorial, autosomal dominants. This is true of at least *A. cognataria* in the U. S., as well. The selection against deleterious dominant mutations is most effective, so that for a dominant mutation to be successful it is not even enough for it to be adaptively neutral; it must have some adaptive advantage attached to it. What are the factors determining whether or not a given moth melanic will succeed biologically (be selected "for" or at least not selected "against")?

The conventional explanation of the development of "industrial melanism" in England was that the melanics had a concealment advantage in the industrial areas. This may be true under conditions of extreme contamination by soot, where the landscape is physically blackened, but it is of dubious value under other circumstances. It is true that in England at least, the highest percentages of melanics have been found to coincide with urban-industrial centers. This has led to an alternative explanation, namely, that the urban-industrial conditions have discouraged predators which would weed out the conspicuous melanics, and that in consequence the pressure of selection has been decreased, allowing the dominant melanics to spread. Further, several authors have reported that the melanics in several Palaearctic species possess a higher survival value under adverse conditions (e.g., semi-starvation) in the larval stage. This higher viability complements the second hypothesis nicely, in that it augments neutrality by giving an advantage which accounts for the rather steep frequency increases observed. This differential viability would be especially significant if it were to be demonstrated that the melanics are more resistant to urban-industrial atmospheric pollutants, such as SO_3 .

It is difficult to state to what degree the melanism in American species is associated with urban-industrial conditions. As previously remarked, there are not sufficient data available for most species to support a meaningful and truly significant analysis. The two exceptions, *A. cognataria* and *P. titea*, so far as the

presently available Pennsylvania data would indicate, seem to follow the British trend of correlation well. Since the urban-industrial complex in question—Philadelphia and vicinity—is not characterized by extensive soot contamination, we may reasonably inquire into the means of maintenance of melanism thereabouts. The only concealment advantage for melanics which is apparent as a result of civilization there would be on asphalt highways; and it is rare indeed to find a moth of any kind resting horizontally on the ground. Most of the species having melanic forms rest by day on tree trunks, and several sit down among dense foliage in the ground-cover story. These facts suggest that of the three possibilities suggested for the maintenance of the melanism, concealment value may be the least significant. We do not, of course, know whether the pleiotropic increased viability exhibited by Cleorine melanics (at least in Europe) is shared by melanics in other species groups; it would be expected that the melanism in various families and subfamilies would have arisen by mutation of various non-homologous genes in somewhat different genetic systems; increased viability would not, then, be likely consequential generally. We do not know enough about moth biochemistry to state whether the viability increase is a direct result of the increase in melanin, or vice versa, or whether the two effects are interlocking but not in direct sequence (as where an enzyme may play a key role in two sets of concurrent reactions). Similar melanizing effects in different species may be produced in quite different ways, by different enzymes in different reaction sequences. The writer would like to see the progress along these lines coming, at last, from the laboratories of American researchers.

ACKNOWLEDGEMENT

The author's thanks to Mr. WILLIAM F. BOSCOE of Philadelphia, Pa., for granting him access to his collection and for furnishing several instances of melanism with which the author was personally unacquainted.

1. *A. cognataria* "ab. *swettaria*" Barnes & McD., 1917 Contr. Nat. Hist. N.A. Lep., III (4), p. 246; also figured, pl. 27, no. 6.
2. *E. virginaria* "form *carbonaria*" Haimbach, Ent. News XXVI (1915), p. 321.
3. *N. quernaria* "form *atrescens*" Hulst, Can. Ent. XXX (1898), p. 162.
4. *E. crepuscularia* "ab. *fumataria*" Minot, Proc. Bost. Soc. Nat. Hist. XIII (1869), p. 84.
5. *C. deridens* "form *fumosa*" Draudt, in Seitz, Macrolep., N.A. Noct. VII (1923), p. 19.
6. *C. deridens* "var. *nigrosuffusca*" Strand, Archives Naturgeschieter, A(2) (1917), p. 46.
7. *H. umbrata* "ab. *nigra*" Chermock, Bull. Brook. Ent. Soc., XXII (1927), p. 118.
8. *F. marthesia* "ab. *nigra*" Chermock, Bull. Brook. Ent. Soc., XXIV (1929), p. 20.

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THE GENUS *LYCAEIDES* IN THE PACIFIC NORTHWEST

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A CRITICAL AND THOROUGH REVISION of the North American forms of the genus *Lycaeides* Hubner was published by Nabokov (1949). The published names of the species and subspecies in the genus were clarified and the basic distribution of the different forms was presented. In this paper, he mentioned the lack of information on species from the Pacific coast, especially north of California. It is the purpose here to provide additional information on the distribution of the species of *Lycaeides* in this area and to present the possible means of the formation and origin of subspecies of *Lycaeides* in the Pacific Northwest. The territory included in this study covers Oregon, Washington, Idaho, southern British Columbia and western Montana. The author looked at and identified the specimens in every major Pacific Northwest collection of butterflies, with the exception of the collection at the University of Idaho.

The genus *Lycaeides* is composed of three species. Two of these are found in the Pacific Northwest. The species *L. argyrognomon* Bergstrasser is found in the mountainous and forested areas; being distributed from approximately 3000 feet to above timberline. *L. melissa* Edwards is a lowland form, occurring in the Great Basin and Columbia Plateau east of the Cascade mountains and is found from 300 to about 3000 feet. *Melissa* is most commonly associated with deciduous forests and the ponderosa pine plant associations (figure 2).

The male genitalia was used to separate *argyrognomon* from *melissa*. Nabokov (1949) showed that this was the best method for distinguishing specimens of heavily marked *argyrognomon* from the normally heavily marked *melissa*. Measurements of the genitalia were not made because of a lack of long series from any one area. Nabokov (1949) attempted this in an effort to separate different subspecies. But as was pointed out by Brown (1950a,b), the measurements were not statistically valid and thus not pertinent for separation of subspecies.

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The initials after the names are used with the locality data to indicate in which collection the individual specimen can be found. In addition, the abbreviations (Nab) and (BVL) were used to indicate the records of distribution published by V. Nabokov and Ben V. Leighton. It should be noted here that B. V. Leighton's "Butterflies of Washington" (1946) has been much criticized. The author does not feel that these criticisms are justified, as it is more reliable than any other published list of the butterflies of the Pacific Northwest. The above published records were included here when the author did not personally see material from the specific localities. Since this paper attempts to clarify the distribution of the *Lycaeides* in the Pacific Northwest, every available and reliable locality record was used.

Lycaeides argyrognomon ricei (Cross) *Plebeius scudderii* ssp. *ricei* Cross, 1937, Pan-Pacific Ent., 13:88.

Lycaeides argyrognomon ricei occurs in the Cascade mountains from Crater Lake, Oregon to the Hope Mts. of British Columbia (Table 1). At the southern end of its range it blends into the Sierra Nevada subspecies *L. a. anna* Edwards. The mountainous area in Oregon from Crater Lake to Mt. Shasta, Calif. is the area of intergradation of *anna* & *ricei*. In subspecies *anna* the underwings are chalk white with distinct black markings, whereas *ricei* is characterized by pale chalk-white ground on the undersides of the wings and by very light black marking on the underwing (fig. 1, nos. 14 & 15). The populations south of Crater Lake have individuals with both characteristics. The Lakeview specimen is an example of this (fig. 1, no. 13).

It would be easy to dismiss this problem by labeling the specimens *L. a. anna* near *ricei*, however specimens of *ricei* from Blue Slide, Washington, Paulina Lake and Gilchrist, Oregon (fig. 1, nos. 10, 11, 12) also show the heavier marked underside characteristic of *anna*. These specimens (fig. 1, nos. 10, 11, 12) come from isolated populations along the eastern edge of the Cascade mountain system. The climate there is different from that of the central Cascades. The summers are longer, hotter and drier. The sun shines almost constantly with little summer precipitation. This is in contrast to the weather of the central Cascades. Here rain, thunder and snow storms are not uncommon, even in July. The Cascade mountains of southern Oregon are broken and the dry eastern weather reaches further west to Medford. Thus several questions are raised. One, are

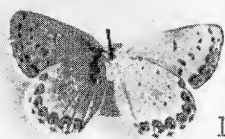
specimens from the drier eastern edge of the Cascades reacting phenotypically to the environment or are these populations just isolated local races? If they are reacting to the environment then are the populations from southern Oregon also examples of this or do they represent an intergradation with the California *anna*? This is a problem not immediately answerable. The author suggests that for convenience all western Oregon *argyrognomon* be referred to as *ricei* and all California *argyrognomon* from the northern part of the state be referred to as *anna*.

At the northern extent of its range, *ricei* is much less complicated than near the southern boundary. In southern British Columbia there is a distinct break between *ricei* and *scudderi* Edwards. In northwestern Washington and southwestern British Columbia the underwings of *ricei* often have some heavy markings. From Lake Chelan, Washington to the Hope Mts. of British Columbia and from the Olympic Mts. of Washington to Vancouver Island, the populations of *ricei* have a varying percentage of specimens with scattered and irregular black markings (fig. 1, nos. 19-22). However the pale chalky underside is retained in all of the males and most of the females. The populations of *scudderi* have an underside ground color that is characteristically light brown (fig. 1, nos. 1, 2). The distinction between the two is definite.

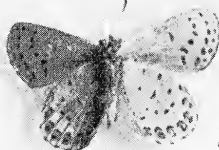
Nabokov (1949) was not sure of where the Vancouver Island, British Columbia populations should be placed. They seem to represent the most northern extension of *ricei*. These specimens all have the chalk white underwing of the typical *ricei*. Each specimen has a strong pattern of dots on the underside of the wing but those dots are irregular and diffused (fig. 1, nos. 20, 21). The dot pattern of *scudderi* is not irregularly distributed and the black dots are definite spots (fig. 1, nos. 1, 2). Blackmore (1927) and Jones (1951) have confused Vancouver Island *argyrognomon* with *melissa*. This mistake should be noted and corrected in any future paper on British Columbia Lepidoptera. In addition, the southern British Columbia populations of *argyrognomon* have been constantly referred to as *anna* (Blackmore, 1927, Jones, 1951). This is due to the heavy marking found on the underwings. However the pattern of these markings is very different from *anna* (fig. 1, nos. 14, 20, 21).

Lycaeides argyrognomon scudderi (Edwards) *Lycaena scudderii* Edwards, 1861, Proc. Acad. Nat. Phil., p. 164.

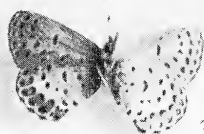
As mentioned above, the separation of *ricei* and *scudderi*



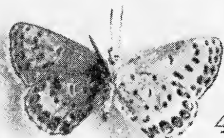
1♂



2♂



3♂



4♂



5♂



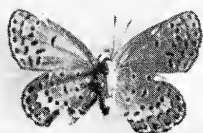
6♂



7♂



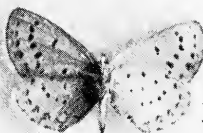
8♀



9♀



10♀



11♂



12♂



13♂



14♀



15♂



16♂



17♂



18♂



19♀



20♂



21♀



22♂



23♂



24♂

is distinct. However, separation of *scudderi* and *melissa* in southern British Columbia is not as simple. Both forms have a definite pattern of black dots on the underside of the wing. Only an examination of the male genitalia will assure adequate separation. The genitalia from specimens of the Okanogan Lake region are always distinctly *scudderi* or *melissa* even though the populations of the two species may be found within a few miles of each other. This is in contrast to the Wyoming area where the genitalia of some specimens are intermittent (Nabokov, 1949). This would suggest that the two species are not interbreeding in the Okanogan area of British Columbia.

The subspecies *scudderi* occupies all of southern continental British Columbia except for the Hope Mountains, the narrow sagebrush-filled valleys, and the extreme southeast corner of the province (Table 1). The Hope Mountains are populated by *L. a. ricei*, the sagebrush by *L. melissa*, and the southeast by *L. a. ferniensis* Chermock.

Nabokov (1949) credited British Columbia with the subspecies *ferniensis* from Ferney and Cranbrook B. C. No specimens were examined from either of these specific localities. However a specimen from Kaslo, just north of Cranbrook, is definitely *scudderi*. Again, as with the *anna-ricei* problem, many more specimens need be collected from the area. Is *ferniensis*

Fig. 1. *Lycaeides argyronomon scudderi*, 1, 2,.; *melissa*, 3, 6, 9; *atraepraetextus*, 4, 5, 7, 8; *ricei*, 10-13, 15-24; *anna*, 14. 1. Salmon arm B.C. 2. Lytton B.C. 3. Oak Creek, Wash. 4. Cornez Creek, Ore. 5. Lake Wallowa, Ore. 6. Pearrygin Lake, Wash. 7. & 8. Oregon Butte, Wash. 9. Kennewick, Wash. 10. Paulina Lake, Ore. 11. Gilchrist, Ore. 12. Blue Slide Lookout, Wash. 13. Lakeview, Ore. 14. Wolverton Mdws., Calif. 15. Tombstone Prairie, Ore. 16. Mt. Rainier, Wash. 17. Crater Lake, Ore. 18. Sheep Lake, Wash. 19. Bunker Hill Lookout, Wash. 20. & 21. Mount Malahat, B.C. 22. Bunker Hill Lookout, Wash. 23. Bradley Creek, Ore. 24. Mt. Cheam, B.C.

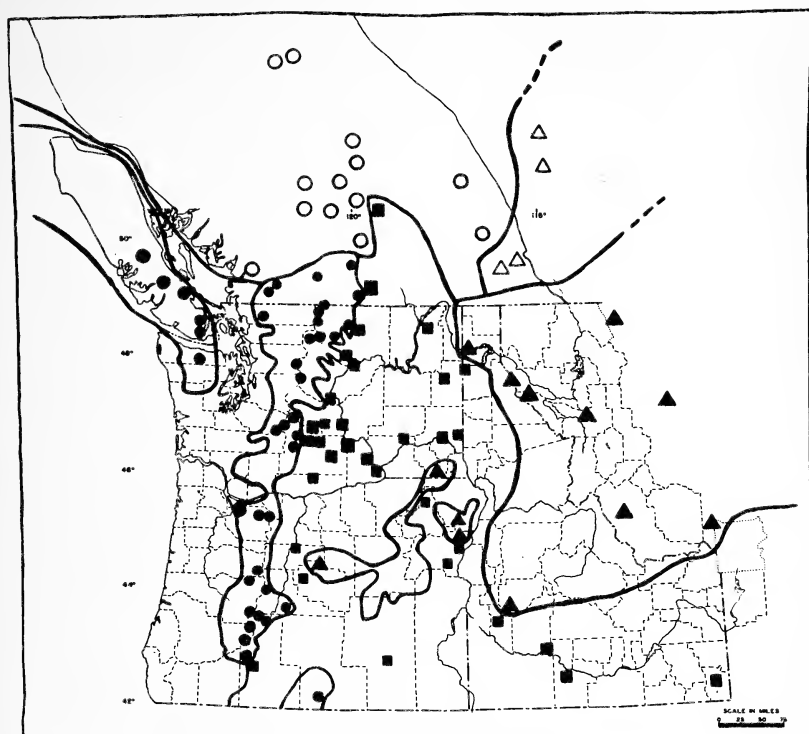
a local form or something of wide enough distribution and distinct enough to deserve a subspecific name? Southeastern British Columbia is composed of many small mountain chains separated by deep valleys. There are many areas where local populations could be isolated and differentiated. Further collecting will be necessary to clarify the concepts of subspecies in this area.

Lycaeides argyrognomon atrapraetextus (Field) *Plebejus atrapraetextus* Field, 1939, Jour. Kansas Ent. Soc., 12:135-136.

This subspecies is found in the Rocky Mountains of Idaho and Montana and in the mountainous areas of eastern Oregon and southeastern Washington (Table 1). This subspecies bears an artificial resemblance to *melissa* because of the heavily marked underwing and the brown color of the underside of the wing. The two forms can be adequately separated only by an examination of the genitalia. The subspecies *atrapraetextus* closely resembles its northern relative *scudderi*. The two are separated by a character on the underside of the hind wing. There is a band of light, almost white, chevrons basal to the outer band of orange markings (fig. 1, nos. 7, 8) in *atrapraetextus*. *Scudderi* has this band reduced to a series of light chevrons, resembling check marks (fig. 1, nos. 1, 2).

When Nabokov (1949) discussed the distribution of this subspecies, he limited it to the mountains of northern Idaho and western Montana. Nabokov had one isolated specimen of *argyrognomon* from near Boise, Idaho which he could not place as to subspecies because he lacked any other specimens from near this locality. The specimens from eastern Oregon and Washington are not sufficiently different from the Idaho and Montana forms to be separated as a subspecies. Thus a connecting link is supplied between Boise and northern Idaho. The author suggests that the name *atrapraetextus* be used to apply to *argyrognomon* from all of Idaho, western Montana, eastern Oregon and southeastern Washington.

A question might arise. Why is there no intergradation between populations of *atrapraetextus* from the Ochoco Mountains, Oregon and populations of *ricei* from just west in the Cascades? The Ochoco's seem to receive all their faunal elements from the Rockies. A narrow but permanent band of juniper separates the Cascades from the mountain ranges of eastern Oregon. This is also an effective barrier for such groups as *Speyeria* Scudder and *Euphydryas* Scudder.



- *Lycaeides argyrognomon ricei* Cross
- *Lycaeides argyrognomon scudderii* Edw.
- △ *Lycaeides argyrognomon ferniensis* Chermock
- ▲ *Lycaeides argyrognomon atraepraetextus* Field
- *Lycaeides melissa* Edw.

Figure 2. The Distribution of *Lycaeides* in the Pacific Northwest.

I would like to thank the following persons for providing me with access to their private or public collections: Dan Carney, E. J. Dornfeld (EJD), Clarence J. Duffy (CJD), M. T. James Washington State University) (WSU), J. D. Lattin (Oregon State University (OSU), David Mays, David McCorkle (DM), Miss Olga Meixner (Vancouver City Museum) (VCM), E. J. Newcomer (EJN), and G. G. E. Scudder (University of British Columbia (UBC).

TABLE 1. DISTRIBUTION RECORDS

L. a. ricei: Oregon-Clackamas Co.: Government Camp, Hwy. 26, July 2, 1934, S. Jewett Jr., 1 ♂, (OSU); Mt. Hood, July 2, 1934, 1 ♂, (OSU); East of Toll Gate, Hwy. 26, July 15, 1906, 2 ♂♂, (OSU). -Deschutes Co.: Paulina Lake, July 28, 1934, S. Jewett Jr., 2 ♂♂ and 2 ♀♀, (OSU). -Douglas Co.: Diamond Lake, July 14, 1937, 1 ♂ and Aug. 16, 1935, 1 ♂ and 1 ♀, H. A. Scullen, (OSU). -Klamath Co.: Bradley Cr., near Windigo Pass, July 25, 1934, S. Jewett Jr., 1 ♂ and 2 ♀♀, (OSU); Crater Lake Park, elev. 6000'-7100', Aug. 13 - Sept. 3, 1930, H. A. Scullen, 4 ♂♂♂ and 3 ♀♀♀, (OSU); Davis Lake, July 23, 1934, S. Jewett Jr., 1 ♂ and 2 ♀♀, (OSU); Gilchrist, Hwy. 97, July 28, 1962, E. J. Dornfeld, 1 ♂, (JHS). -Lake Co.: 6 mi. West of Lakeview, July 8, 1937, elev. 5100', Bollinger and Jewett, 1 ♂, (OSU). -Lane Co.: McKenzie Bridge, Hwy. 126, Aug. 25, 1906, 1 ♂, (OSU); Mule Prairie, Hwy. 58, elev. 4400', July 11, 1962, E. J. Dornfeld, 2 ♂♂, (JHS); Willamette Pass, elev. 5000', July 3, 1959, E. J. Dornfeld, 1 ♂, (JHS). -Linn Co.: Lost Prairie, Hwy. 20, elev. 3400', July 3, 1961, E. J. Dornfeld, 1 ♂, (JHS); Tombstone Prairie, Hwy. 20, elev. 4200', Aug. 4, 1960, E. J. Dornfeld, 1 ♂, (JHS). -Multnomah Co.: Grahams, 4 mi. East of Portland, July 15, 1906, 1 ♂, (OSU). -Washington-Chelan Co.: Crockers Cabin, near Bridge Creek, July 22, 1960, C. J. Duffy, 2 ♂♂ and 1 ♀, (CJD); Twisp Pass, elev. 6066', July 18, 1960, C. J. Duffy, 2 ♂♂, (CJD). -Clallam Co.: Olympic Mts., 1 ♂, (WSU). -King Co.: Stephens Pass, Aug. 9, 1961, D. McCorkle, 2 ♂♂ and 1 ♀, (DM). -Okanogan Co.: Bunker Hill Lookout, elev. 6950', July 19 - Aug. 14, 1961, J. Shepard, 11 males and 12 females, (JHS); Camp Gilbert, (NAB); Cooney L. Trail, (BVL) (Nab); Foggy Dew Creek, (Nab); Gold Creek, (Nab); Harts Pass, Aug. 1, 1959, D. McCorkle, 2 ♂♂, (DM); North Creek, July 39, 1960, C. J. Duffy, 1 ♂ and 1 ♀, (CJD); Pasayten Airport, elev. 4200', June 27, 1961, J. Shepard, 10 males and 6 females, (JHS); Salmon Mdws., Aug. 2, 1958, D. McCorkle, 1 ♂, (DM); Slate Peak, Aug. 13, 1961, D. McCorkle, 1 ♀, (DM); and Sept. 5, 1961, J. Pederson, 1 ♀, (JHS). -Pierce Co.: Mt. Rainier, (BVL) (Nab); Reflection Lakes, Mt. Rainier Nat. Park, July 20, 1960, J. Shepard, 3 ♂♂♂, (JHS); Tipsoo Lake, (BVL). -Snohomish Co.: Blue Lake, (BVL). -Whatcom Co.: Mt. Baker, (Nab) (BVL); Skyline Ridge, near Mt. Baker, (BVL); Table Mt., near Mt. Baker, (BVL). -Yakima Co.: Bethel Ridge, Aug. 11, 1958, E. J. Newcomer, (EJN); Blue Slide Lookout, elev. 6870', Aug. 6 and 7, 1959, J. Shepard, 2 ♂♂ and 1 ♀, (JHS); Chinook Pass (Sheep Lake Trail), D. McCorkle, Aug. 2, 1958, 1 ♂ and 1 ♀, Sept. 2, 1960, 1 ♂ and 1 ♀, Sept. 7, 1960, 1 ♂, (DM); Chinook Pass (Sheep Lake Trail), Sept. 6, 1962, J. Shepard, 8 males and 3 females, (JHS); Ravens Roost, near Cliffdell, Aug. 9, 1958, D. McCorkle, 1 ♂, (DM); Sheep Lake, July 25, 1958, E. J. Newcomer, (EJN). -British Columbia-Alberni Dist.: Mt. Corley, July 22, 1951, J. R. Jones, 1 ♀, (UBC). -Comox Dist.: Mt. Beecher, Forbidden Plateau, July 17, 1951, 1 ♂, (UBC). -Malahat Dist.: Gold Stream, July 9, 1923, J. F. Clarke, (WSU), July 1 and 3, 1921, E. Blackmore, 1 ♂ and 1 ♀, (UBC), July 3-5-8, 1918, E. Blackmore, 3 ♂♂♂, (UBC), June 27, 1898, E. Blackmore, 1 ♀, (UBC); Mt. Malahat, June 8 - Aug. 5, 1931 - 1951, J. R. Jones, 13 males and 6 females, (UBC); Shownigan Lake, June 23, 1925, E. Blackmore, 1 ♂, (UBC). -Osoyoos Dist.: Okanogan Lake, (Nab); Peachland, (Nab). -Shaw-nigan Dist.: July 21, 1948, J. R. Jones, 1 ♂, (UBC). -Similkamean Dist.: Keremeos Creek, June 24, 1 ♂, (UBC). Victoria Dist.: Victoria, June, 1934, W. Downes, 1 ♂, (UBC). -Wellington Dist.: Wellington, July 3, 1902, E. Blackmore, 1 ♂, (UBC). -Yale Dist.: Coalmont, (Nab); Hope Mt., July 19, 1906, 2 ♂♂ and 1 ♀, (UBC); Mt. Cheam, Aug. 17, 1922, W. B. Anderson, 1 ♂, (UBC), July 24, 1915, R. C. Trenherne, 1 ♂, (UBC), Sept. 13, 1924, 1 ♂, (VCM). Genitalia Examined: Washington; Pasayten Airport (1), Bunker Hill Lookout (1), Mt. Rainier (1). -Oregon; Lakeview (1). -British Columbia; Mt. Malahat (1).

L. melissa: British Columbia-Kamloops Dist.: Sicamous, (Nab). -Penticton Dist.: June 15, 1918, W. B. Anderson, 2 ♂♂, (UBC). -Similkamean Dist.: Vasseaux Lake, June 14, 1919 and June 25, 1920, W. B. Anderson, 1 ♂ and 1 ♀, June 13, 1919, R. C. Treherne, 1 ♂, (UBC); Okanogan Falls, (Nab). -Idaho-Ada Co.: Kuna, (Nab). -Beaver Lake Co.: Nounan, (Nab). -El-

mer Co.: Kings Hill, (Nab). -Kootenai Co.: Twin Lakes, (Nab). -Twin Falls Co.: Rock Creek, near Buhl, June 27, 1935, R. Miller, 1 ♂, (RM). -Oregon-Baker Co.: Durkee, July 24, 1941, J. Baker, 1 ♂, (EJD), Aug. 27, 1940, L. W. Motley, 2 ♂♂, (OSU); Eagle Creek, near Richland, July 11, 1960, J. Baker, 3 ♂♂♂, (EJD). -Crook Co.: Crooked River, June 23, 1906, 2 ♂♂, (OSU); 98 mi. East of Bend, Aug. 20, 1945, H. A. Scullen, 1 ♂, (OSU). -Harney Co.: Frenchglen, elev. 4200', July 24, 1935, 6 males and 1 female, (OSU), Aug. 6, 1960, E. J. Dornfeld, 2 ♀♀, (EJD), July 26, 1962, E. J. Dornfeld, 1 ♂, (EJD). -Jefferson Co.: Gateway, 1 ♂, (OSU). -Klamath Co.: Fort Klamath, (Nab). -Union Co.: Elgin, June 18, 1960, R. Miller, (RM). -Washington-Benton Co.: Kennewick, June 6 - Sept. 17, 1958 - 1960, J. Shepard, 5 ♂♂♂♂ and 2 ♀♀, (JHS); Richland, June 9, 1960, J. Shepard, 1 ♂, (JHS); Vernita, July 25, 1959, D. McCorkle, 1 ♂ and 1 ♀, (DM). -Chelan Co.: Wenatchee, (BVL). -Franklin Co.: Kahlolus Lake, May 14, 1960, J. Shepard, 1 ♂, (JHS). -Kittitas Co.: Ellensburg, (Nab); Nelson's Landing, (Nab); Vantage, May 14, 1960, D. McCorkle, 2 ♂♂, (DM). -Klickitat Co.: Satus Pass, June 15, 1960, D. McCorkle, 2 ♂♂, (DM). -Okanogan Co.: Black Canyon, (BVL); Brewster, (Nab); Fish Lake, near Conconully, Sept. 14, 1960, D. McCorkle, 1 ♂, (DM); Pearygin Lake, June 17, 1961, J. Shepard, 2 ♂♂ and 1 ♀, (JHS); South Creek, July 9, 1960, C. J. Duffy, 1 ♂, (CJD); Winthrop, July 9, 1960, C. J. Duffy, 2 ♀♀, (CJD), and June 17, 1961, J. Shepard, 1 ♂, (JHS). -Pend Oreille Co.: Ruby, (BVL). -Spokane, (BVL). -Whitman Co.: Almota, July, (WSU); Pullman, (BVL). -Yakima Co.: Bear Canyon Road, Hwy. 5, July 5, 1962, D. McCorkle 1 ♂, (DM); Cottonwood Creek, elev. 2000', June 15, 1959, E. J. Newcomer, 1 ♂ and 1 ♀, (EJN); Oak Creek, elev. 2000', June 7, 1961, J. Shepard, 3 ♂♂♂, (JHS); Priest Rapids, elev. 500', June 2, 1959, E. J. Newcomer, 1 ♂, (EJN); Tieton, (BVL); Wenas Creek, elev. 2500', May 20, 1959, E. J. Newcomer, 1 ♂, (EJN); Yakima, July 26, 1922, W. Downes, 1 ♂ and 1 ♀, (UBC); Zillah, Aug. 23, 1958, D. McCorkle, 6 males and 2 females, (DM). Genitalia Examined: Washington; Kennewick (1), Oak Creek (1), Pearygin Lake (1). -Oregon; Durkee (1), Frenchglen (3), Crooked River (1), Gateway (1). -British Columbia; Penticton Dist. (2), Vasseaux Lake (1).

L. a. atrapraeextus: Oregon-Baker Co.: Cornucopia, elev. 7100', July 25, 1936, R. E. Rieder, 1 ♂, (OSU). -Crook Co.: Cornez Creek, Aug. 15, 1959, E. J. Dornfeld, 2 ♂♂ and 2 ♀♀, (JHS); Marks Creek Lodge, July 20, 1958, E. J. Dornfeld, 2 ♂♂, (JHS); Viewpoint Road, July 23, 1960, E. J. Dornfeld, 2 ♂♂ and 3 ♀♀, (JHS). -Wallowa Co.: 2 miles South of Wallowa Lake, Sept. 1, 1962, D. Mays, 1 ♂ and 1 ♀, (JHS). -Washington-Columbia Co.: Oregon Butte, elev. 6400', July 20, 1958, R. Miller, 2 ♂♂ and 2 ♀♀, (JHS). -Idaho-Bonner Co.: Priest River, (Nab). -Shoshone Co.: Uranus Peak, (Nab). -Montana-Beaverhead Co.: Polaris, (Nab). -Cascade Co.: King's Hill, (Nab). -Gallatin Co.: Gallatin Valley, July 18, 1936, W. Downes, 1 ♂ and 1 ♀, (UBC). -Glacier Co.: Garden Wall, (Nab). -Jackson Co.: Elkhorn Road, (Nab). -Mineral Co.: De Borgia, elev. 3000', July 23, 1957, E. J. Newcomer, 1 ♀, (EJN). Genitalia Examined: Washington; Oregon Butte (1). -Oregon; Cornez Creek (1), Cornucopia (1), Lake Wallowa (1), Marks Creek (2). -Montana; De Borgia (1), Gallatin Valley (1).

L. a. scudderii: British Columbia-Cariboo Dist.: Cariboo, July 10, 1920, 1 ♂, (UBC); Quesnel, (Nab); Stanley, (Nab). -Kamloops Dist.: Armstrong, June 29 - July 10, 1914, W. Downes, 4 ♂♂♂♂ and 3 ♀♀♀, (UBC); Chase, Aug. 9, 1919, W. B. Anderson, 1 ♂ and 1 ♀, (UBC); Enderby, June 18 - Aug. 15, 1920 - 1922, J. Wynne, 4 ♀♀♀♀, (UBC); Hefferly Creek, (Nab); Nicolo Lake, June 17, 1922, W. R. Buckell, 1 ♀, (UBC); Salmon Arm, April 25 - June 17, 1914 - 1921, W. R. Buckell, 8 males and 1 female, (UBC); Vaneby, elev. 4500', Aug. 10, 1921, 1 ♀ and June 21, 1921, 1 ♀, T. A. Moillet, (UBC); Vernon, June 22 - Aug. 10, 1904 - 1919, 4 ♂♂♂♂ and 4 ♀♀♀♀, (UBC). -Kootenay Dist.: Carbonate, (Nab); Kaslo, 1897, 1 ♂, (UBC); Revelstoke Mt., Aug. 14, 1923, W. R. Buckell, 6 males and 2 females, (UBC). -Lillooet Dist.: Lillooet, July 10, 1922, K. F. Anderson, 1 ♂, (UBC); Jesmond, (Nab); Pavilion, July 18, 1933, W. Downes, 2 ♂♂ and 1 ♀, (UBC). -New Westminster Dist.: New Westminster, (Nab). -Osoyoos Dist.: Kelowna, (Nab). -Peace River Dist.: Rolla, (Nab). Genitalia Examined: British Columbia; Armstrong (2), Chase (1), Kaslo (1), Lytton (1), Revelstoke Mt. (1), Salmon Arm (1), Vernon (1).

Lycaeides melissa (Edwards)

Lycaena melissa Edwards, 1873, Trans. Amer. Ent. Soc., 4:346-348.

L. melissa is found in the Pacific Northwest only in the central Columbian Plateau, the Snake River drainage lowlands, and the Great Basin area of southern Oregon (Table 1). It can be confused with certain subspecies of *argyrognomon*. The distinctions have been discussed under those respective subspecies; *scudderi* and *atrabraetextus*.

The habitat is much more varied for *melissa* than for *argyrognomon*. On the east side of the Cascades it can be found in ponderosa forests. From there it invades the lowland sagebrush country only along streams where deciduous growth is supported. It is not found directly in the dry sagebrush. Also it is commonly found in the valleys of Oregon and Washington where irrigation and farming occur. Along the Snake River, Columbia River and in southern Oregon it is found near streams and irrigated regions. The species *melissa* can succeed in invading mountains only to the limit of continuous ponderosa pine distribution. Then the species *argyrognomon* is dominant.

Nabokov (1949) pointed out several places where *argyrognomon* and *melissa* were sympatric i.e. Brewster, Washington and Fort Klamath, Oregon. This sympatricity has never been found by the author or by any of the Pacific Northwest collectors with whom he has communicated. The Brewster records are not especially reliable for specimens that are normally mountain forms. Remington (1963) has recently brought attention to the labels of T. C. Hopfinger (of Brewster). The *ricei* specimens labeled Brewster could never have been taken exactly there. The same is probably true for the specimens from Fort Klamath. That is, they were not taken together but at close localities separated by wide ecological differences.

In Wyoming, where Nabokov (1949) has demonstrated the interbreeding of the two species, *argyrognomon* and *melissa*, it would appear that the two are able to occupy the same microhabitat and thus interbreed. In the Pacific Northwest, other than perhaps extreme southeastern Idaho, the two species have definite and separate ecological preferences.

The distribution of the genus *Lycaeides* in the Pacific Northwest is very similar to that of the bird genus *Zonotrichia* Rand (1948). Rand discussed the origin of this and several other bird genera in relation to the effect of the Wisconsin glacial period

on the isolation of species of birds to form subspecies. Rand proposed that at the glacial maximum there were four refugia where animal species were isolated. These areas were northwest Alaska, the Pacific coast, Rocky Mountains, and eastern United States. The various groupings of the subspecies of *argyrognomon* correspond well to these refugia. *L. ricei*, *anna*, and *lotis* Linter, found on the Pacific coast, are one group characterized by an underwing with a chalky white groundcolor. *Alaskensis* Chermock and *scudderi*, distributed from southeastern Alaska to southern British Columbia are another natural grouping. These two subspecies blend into each other and specimens from the intermittent area are not easily assigned to either subspecies. *Atrapraetextus* from the central Rockies and *aster* Edwards from eastern United States are the two other groupings corresponding to Rand's bird distribution. In addition there is a fifth group including *sublivens* Nabokov and *longinus* Nabokov. These are found in the Rocky Mountains south of Montana. There was an extensive glacial sheet covering northwestern Wyoming during the Wisconsin period (Kamp, 1963). This was likely the factor that separated *argyrognomon* to form *sublivens* and *longinus*.

Since *argyrognomon* formed subspecies as a result of glaciation during the Wisconsin, it and the species *melissa* must have been separated as species prior to this time.

SUMMARY

There are two species of *Lycaedis* in the Pacific Northwest, *argyrognomon* and *melissa*. *Argyrognomon* has formed three subspecies *ricei*, *scudderi*, and *atrapraetextus*. These subspecies probably resulted from a break-up of the species during the Wisconsin glacial period.

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THE ORIGIN OF A SYMPATRIC SPECIES IN COLIAS THROUGH THE AID OF NATURAL HYBRIDIZATION

WILLIAM HOVANITZ

(continued from volume 2, page 223)

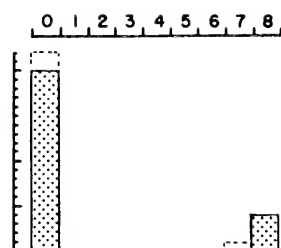
V POPULATION COMPARISONS

Section IV of this series showed by means of scatter diagrams, the relationship between the variations of two characteristics in arctic populations of *Colias*. This section (V) will show the general distribution within each population of each of the two characteristics so as to give a better idea of the nature of the introgression within the populations in a way that the conelation diagrams could not indicate.

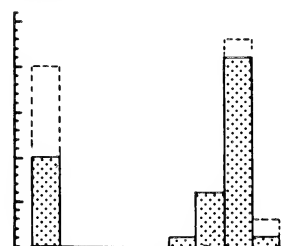
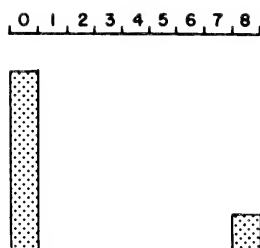
The characteristics are those previously illustrated on figure 8 (page 271, vol. 1) and fig. 9 (page 206, vol. 2), each being graded in a series of nine classes, 0, 1, 2, 3, 4, 5, 6, 7 and 8. Using these classes, histograms have been constructed based upon the numerical values for each class. The histograms so constructed are illustrated in figures 43 through 49.

to be continued

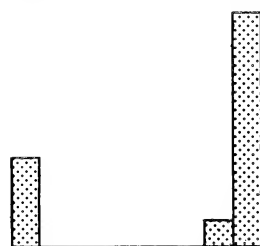
Figures 43 through 49. Histograms illustrating the variation in pigmentation (left) and border pattern grade (right) of various arctic populations. The grades have been illustrated in earlier sections of this paper. Note that some populations (such as Lake Harbour) show no introgression but only *Colias hecla* or *Colia nastes*, others (such as Reindeer depot) show no introgression but only one species, either *C. nastes* or *C. hecla*, and others show a wide range of introgression with or without many parental species (Spence Bay, Coral Harbour, Repulse Bay, Chesterfield Inlet).



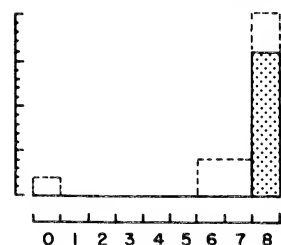
LAKE HARBOUR



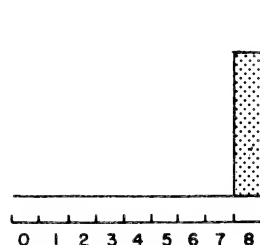
SUGLUK



KEEWATIN

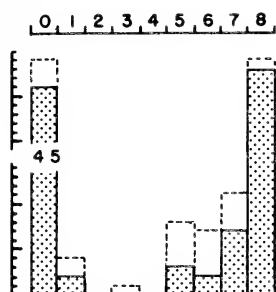
CLYDE, BAFFIN
ISLAND

KIDLURT

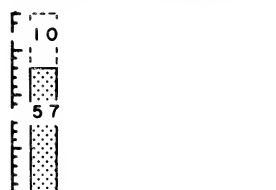


ORANGE

BORDER



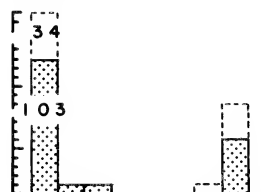
BAKER LAKE



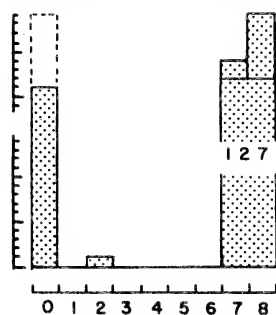
FORT CHIMO



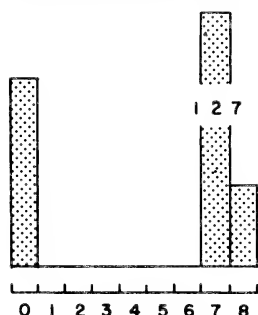
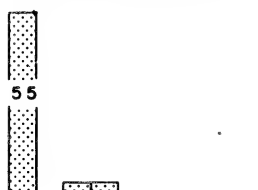
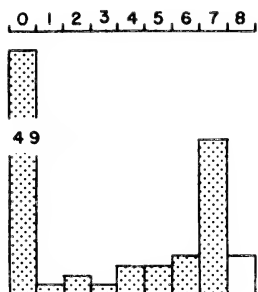
PAYNE BAY



PORT HARRISON

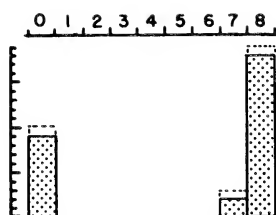


FROBISHER BAY

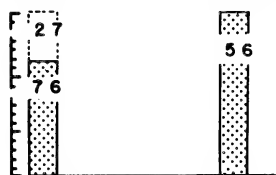


ORANGE

BORDER



FIRTH RIVER



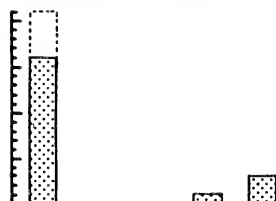
HERSCHEL ISL.



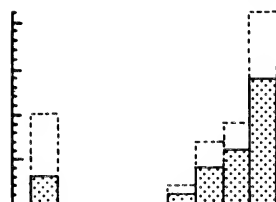
COPPERMINE



COPPERMINE

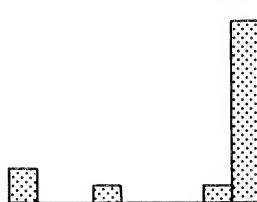
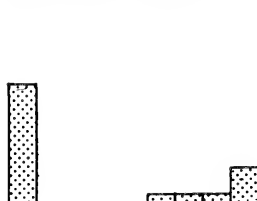
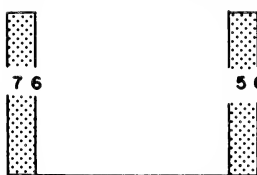
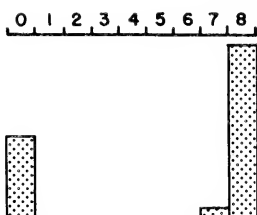


HOLMAN ISL.

BATHURST
INLET

0 1 2 3 4 5 6 7 8

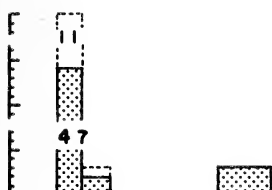
ORANGE



0 1 2 3 4 5 6 7 8

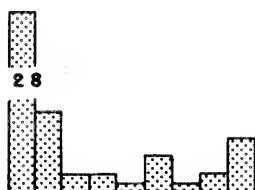
BORDER

0 1 2 3 4 5 6 7 8



CAMBRIDGE BAY

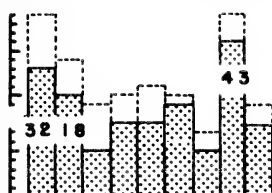
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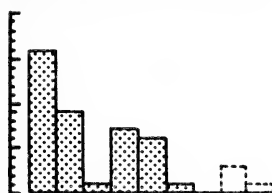
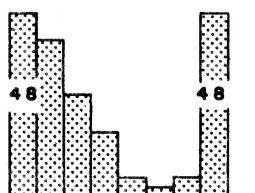
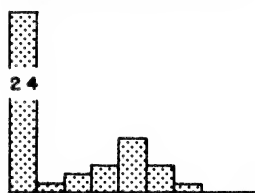
MUSKOX LAKE



EUREKA



SPENCE BAY

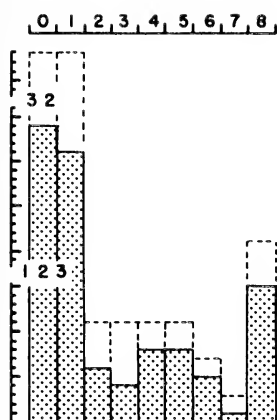
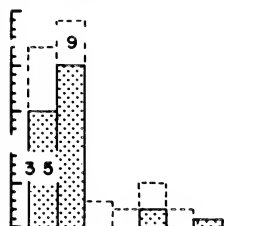
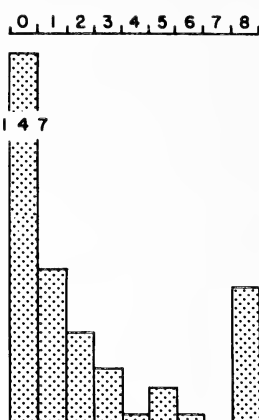
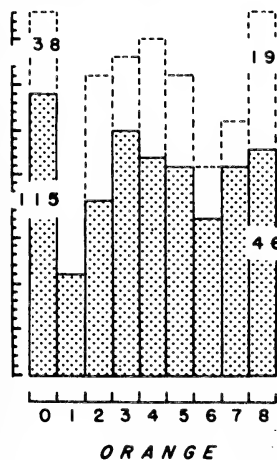
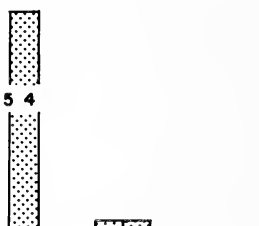
CORAL HARBOUR
(1932)

0 1 2 3 4 5 6 7 8

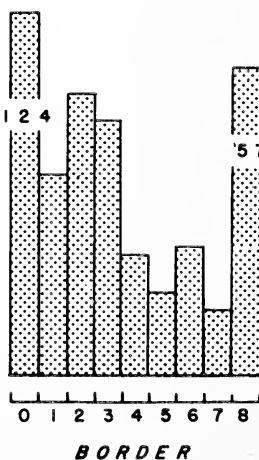
ORANGE

0 1 2 3 4 5 6 7 8

BORDER

CORAL HARBOUR
(1952)CORAL HARBOUR
(1948)

REPULSE BAY



BORDER

0 1 2 3 4 5 6 7 8



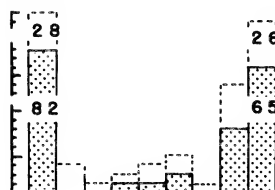
DANSKE

14



CHURCHILL

43



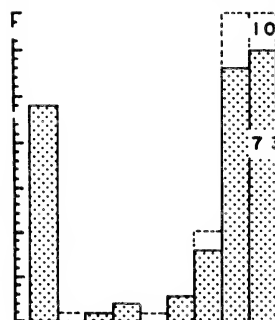
ESKIMO POINT

82

65



PADLEI

CHESTERFIELD
INLET

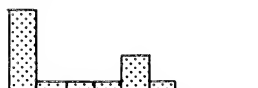
10

73

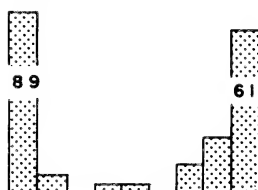
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ORANGE

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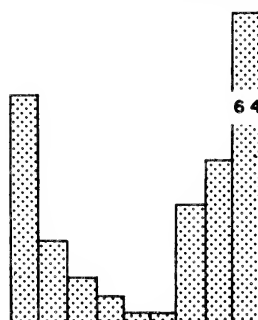


43



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61

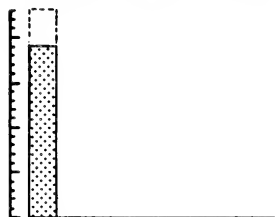


64

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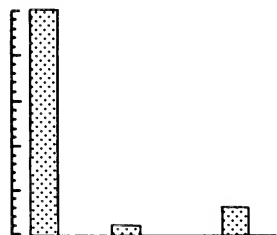
BORDER

0 1 2 3 4 5 6 7 8



REINDEER DEPOT

0 1 2 3 4 5 6 7 8



MEADE RIVER

0 1 2 3 4 5 6 7 8

ORANGE



0 1 2 3 4 5 6 7 8

BORDER

(to be continued)

THE SOUTHERN LIMITS OF THE RANGE OF *PIERIS NAPI* AND *P. VIRGINIENSIS*

BRYANT MATHER

P. O. Box 2131, Jackson, Mississippi

HOVANITZ (1962, 1963) has reviewed and discussed the distribution of the species of *Pieris* in North America and the relation of *P. virginienensis* Edwards to *P. napi* Linnaeus. This note reviews some of the literature on the southern limits of these species, comments on the reported occurrence of *P. virginienensis* in eastern Colorado; its probable occurrence in Mississippi; and on the reported occurrence of *P. napi* at Waco, Texas and in the "northern limits of the Gulf States."

Klots (1951) wrote: "Until very recently, *virginienensis* has been confused with *napi*, but it is now known to be a distinct species of more southern (Transition Zone) distribution. . . Old records are unreliable since Scudder, Edwards, etc. confused this species with *napi*." He gave the range of *napi* as: "Canadian Zone of northern United States and Canada, w. to the Pacific. . . Not recorded s. of the Catskill Mountains in New York" and of *virginienensis* as: "Transition Zone, Ontario, central New England and New York, s. to Virginia (TL. Kanawha, W. Va.)." Since he also stated: "True Canadian Zone runs far southward at high elevations along the Appalachians, not, of course, in a continuous strip. It is thus recognizable as far south as Georgia." He clearly implied that the southern limit of the known range of *napi* is far north of the southern limit of areas recognizable as true Canadian Zone.

Holland (1931), included *virginienensis* as a form of *napi*, and stated that *napi* "ranges from the Atlantic to the Pacific and from Alaska to the northern limits of the Gulf States." If Alabama is considered as a "Gulf State" then its northern limit near Chattanooga may be regarded as including Transition or even Canadian Zone elements similar to those in what Harris (1950) has designated the "mountain region" of north Georgia. Clark (1932) stated that *P. virginienensis* occurred in the highlands to North Carolina and quoted W. T. M. Forbes to the effect that his most northern record of *virginienensis* was the southern slope of the Adirondacks while he had no *P. napi* records south of the Mohawk Valley. Forbes (1960) wrote that *P. napi* had the range: "Western Massachusetts and northern

New York to Colorado and north;" and that *P. virginiensis* had the range: "from Quebec to Massachusetts and West Virginia, west to Michigan." Tietz (1952) had no *napi* records from Pennsylvania, and *virginiensis* records only from the Austral Zone (Allegheny Co.). His map shows the northern portion of Allegheny Co. as Transition Zone. Clench (1958) found *virginiensis* common at the Powdermill Nature Reserve in eastern Westmoreland Co., an area that appears to include both Canadian Zone and Transition Zone elements.

Harris (1950) did not mention *virginiensis* as known or probable for Georgia. Remington is quoted in Mather and Mather (1958) as having written that *virginiensis* is locally common in Tennessee and Lindsley (1960) reported it has having been found "in fair numbers" on 22 April 1959 in the Great Smoky Mountain National Park, Tenn. Field (1940) did not mention *virginiensis* or *napi* as possible for Kansas. Martin and Truxal (1955) reported specimens of *virginiensis* from Michigan, Minnesota, and Wisconsin; and of *napi* from Arizona, New Mexico, Utah, Colorado, Wyoming, and states north and west thereof. Remington (1952) reported observations of oviposition by *napi* at several Colorado localities. Brown, Eff, and Rotger (1956) described the occurrence of *napi* in Colorado and noted that it is rarely found below 9000 ft. above sea level. Brown, Eff, and Rotger (1957) also discussed the report by Cross (1937) that *virginiensis* "occurs on our eastern plains" and stated "This is impossible" adding "I cannot imagine what species Cross confused with this one." DeFoliart (1956) gave records of *napi* from southeastern Wyoming and Elrod (1906) gave records from Montana. Remington (1954) gave the name *macdunnoughii* to the race of *napi* found in Colorado, Utah, Nevada, and Wyoming.

Voss and Wagner (1956) discussed the occurrence of both *napi* and *virginiensis* in Michigan. They gave the range of *virginiensis* as "from Ontario, New England, and New York, southward to North Carolina." Reinthal (1956) discussed the occurrence of *virginiensis* in Connecticut and Massachusetts. Both Voss and Wagner, and Reinthal describe localities in Michigan and Massachusetts, respectively, at which both species were found flying together. Simmons (1956) described the occurrence of *virginiensis* in Maryland. Macy and Shepard (1941) make no mention of *virginiensis* and state that in Minnesota *napi* "occurs almost exclusively in the northern part of the state."

Gooch and Strecker (1924) discussed the butterflies of the vicinity of Waco, Texas. They stated that the majority of the

butterflies were collected between 1904 and 1908. "In 1905, a series of duplicates were presented to the Carnegie Museum of Pittsburgh, Penna., and we are indebted to Dr. W. J. Holland for the positive identification of many of the smaller species." Three species of *Pieris* were listed: "*P. protodice*: abundant; *P. rapae*: very common; and *P. napi*: 'The 'Butterfly Book' gives the range of this species as 'from the Atlantic to the Pacific, and from Alaska to the northern limits of the Gulf States' Waco specimens of this butterfly were sent to Dr. Holland and he identified them as *napi*. It is rather common." Mr. H. A. Freeman wrote (*in litt*) "I don't have any idea as to what they could have been calling *Pieris napi* from down this way, as it certainly has not been collected around here since I have lived in the state. Belfrage most likely made the collections and some of his material is in the Carnegie Museum." Mr. H. K. Clench wrote (*in litt*) "I have given the collection a careful going over, and can find nothing at all among all the *napi* and *virginiensis* labelled as from Waco, Texas or anywhere near there. I cannot imagine what Holland could have mistaken for *napi*."

From these data and comments it would appear that the range of *P. napi* in the United States includes most of the New England states, New York state south to the Catskills and Adirondacks, northern Michigan, northern Minnesota, the Rocky Mountains in Wyoming, Montana, Colorado, New Mexico, and westward through Arizona, Utah, and Nevada to California and the Pacific northwest. *P. virginiensis* generally occurs downhill or down range from *napi* but the southern range of *napi* overlaps the northern range of *virginiensis* at least in some places such as Massachusetts and Michigan. The southern limit of the range of *virginiensis* appears to be reached in the Appalachian mountains of west Tennessee and eastern North Carolina, the western part of Pennsylvania, and central Michigan. Data appear to be lacking as to the possible westward extension of the range of *P. virginiensis* bordering the southern or eastern edge of the range of *napi* into Wisconsin and Minnesota and along the front of the Rocky Mountains. The reported occurrence of *virginiensis* downhill from the range of *napi* in eastern Colorado was regarded as "impossible" by those who have most recently studied the distribution of Colorado butterflies. It also appears to be impossible to determine the basis on which *napi* (or *virginiensis*) was reported to occur at Waco, in central Texas; or "to the northern limits of the Gulf States." These latter reports formed the basis on which Mather and Mather (1958) reported *vir-*

giniensis as possible but not likely for Mississippi. From the present review, *virginiensis* would appear impossible of occurrence in Mississippi.

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LIFE HISTORIES OF *PAPILIO INDRA* AND *P. OREGONIUS*¹

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1509 Summitview, Yakima, Washington

PAPILIO INDRA

Papilio indra Reakirt is usually described as an erratic flier, elusive and occurring in high mountains; and it does have such a habitat in California and Colorado. In the north it has been taken in Oregon in Baker, Grant and Jefferson Counties, at elevations of 2,000 to 7,000 feet; and in Washington in canyons along the east slope of the Cascade Mountains and in the Blue Mountains, at elevations of 500 to 6,000 feet. It has apparently not been found in British Columbia (Llewellyn Jones, 1951). This occurrence at lower elevations makes it much less elusive and more easily taken. Males may be found at wet, sandy spots along streams, sometimes in fair numbers. The females are seldom encountered, however, and then usually on flowers or flying about the food plants.

In May, 1963, the writer chanced upon a female ovipositing, and was able to capture it. It was put into a plastic ice-cream cup with some of the food plant, where it deposited 20 eggs between May 24 and 28, when it died. This has made possible a study of the early stages.

Scraps of information on the immature stages of this species have been published, chiefly to the effect that in California larvae have been found on an umbelliferous plant, *Pteryxia* (*Cymopteris*) *terebinthina* (Emmel and Emmel, 1963). The plant on which the female mentioned above was ovipositing is *Lomatium grayi*, another umbellifer. This particular specimen was taken along Kusshi Creek, in the Simcoe Mountains in Yakima County, Washington. *L. grayi* is exceedingly common on the floor of this canyon, as well as along other creeks where *indra* occurs.

There is only one brood in Washington, the adults flying at lower elevations from April to the middle of June, and at higher elevations in July. At room temperature in May the egg stage lasted 6 days and the larval period took about 18 days. Thus larvae coming from eggs laid May 24-28 were pupating June 18-20. So the insect is in the pupal stage about 11 months.

¹The botanical nomenclature used in this paper is in accordance with that of Leroy Abrams, "Illustrated Flora of the Pacific States." Stanford Univ. Press, vol. III, 1951; vol. IV, 1960.

Food plants. — As mentioned, *indra* feeds on *Pteryxia terebinthina* in California. This plant grows in the Yakima Valley and may be a food plant here, although it does not seem to occur in the canyons where *indra* flies. Other food plants that have been mentioned include *Tauschia (Velaea) parishii* and *Cymopteris panamintensis*, both umbellifers and both found only in California (Wilson, 1961). Wilson also lists *Artemisia dracunculoides*, which is a composite and is the food plant of *P. oregonius* and *bairdi*. However, as a rule it does not grow where *indra* flies. The writer did not have an opportunity of testing *indra* larvae on this plant, but David V. McCorkle, in a letter, states that he placed sprigs of it with last-instar larvae but they would not feed on it. Emmel and Emmel (1963) credit Edwards with the statement that this *Artemisia* is a food plant but express doubts about it. Considering the evidence, it would probably be safe to say that *indra* does not feed on it. In Washington, *indra* evidently feeds primarily on *Lomatium grayi*, and sometimes on *L. triternatum* and possibly on *L. nudicaule*, both of which occur in the *indra* habitat.

DESCRIPTION

Papilio indra

EGG. --Spherical, slightly flattened at base if deposited on a flat surface, but not otherwise; creamy with a slight greenish tinge; surface very finely pitted. Within two days a brownish ring develops around the circumference as well as a brownish area at the micropyle. When viewed with a Stereozoom binocular at 30 X, these areas appear to be made up of irregular brownish patches just beneath the surface. Before hatching the egg becomes totally black. Diameter, 1 mm.

LARVA. FIRST INSTAR. --Head and thoracic legs shiny black; body dull black dorsally and laterally with numerous white spots of various sizes, the larger ones forming bands on segments 1, 2 and 6; the spots somewhat more numerous on 10, 11 and 12; a row of shiny black tubercles on each side of the dorsum, each one supporting one large seta and several smaller ones; other smaller spined tubercles laterad; two large tubercles on segment 1, one on each side of the dorsum; a few small setae on the ventral surface. Length, 2.5-3 mm., width at segment 1, 0.75 mm., tapering posteriorly.

SECOND INSTAR. --Same as first, except tubercles have lost their setae, and white areas have become yellowish. Also bright orange osmateria have developed. Length, 5 mm.

THIRD INSTAR. --Same as second. Length, 10-15 mm.

FOURTH INSTAR. --Head with transverse black bar at front and inverted black V posteriorly; otherwise yellowish; yellowish patches on body have disappeared; tubercles not evident but yellow spots at their bases still present; otherwise velvety black except for a narrow, transverse white band on segment 1 and a wider one on the last segment; location of osmateria marked by two yellowish spots; legs as before. Length, 20-22 mm.

FIFTH INSTAR. --When full grown, head as before; body velvety black with pinkish transverse stripe across anterior third of each segment; two ochre-yellow spots, one on each side of dorsal line, and a smaller yellow spot dorso-laterally. Pinkish stripe on body varies in width; if wide, the spots are connected with it; if narrow, they are separate; another series of spots laterally, yellow on segments 2 to 10, and white on 11; ventral area mostly dull black; thoracic legs black; prolegs black laterally, bluish ventrally; a triangular bluish area on each segment just above each proleg. Length, 35-40 mm.

PUPA. --Typical *Papilio* shape, except rather smooth, cephalic protuberances lacking; those on thorax less prominent than on chrysalids of *rutulus*, *zelica* or *oregonius*; at first wing covers and thorax dull green, becoming olive green; abdomen light creamy brown, mottled with darker brown; these colors persist. Length, 25 mm.

HABITS. --The newly hatched larva eats its egg shell, and at each molt the larva eats the exuvium but not the head capsule, which usually falls away. One such procedure was observed. After being quiet for nearly 36 hours, a fourth-instar larva molted. It then remained quiet for a half hour, then turned around and ate the entire exuvium. It then remained quiet again for some hours before resuming feeding.

PAPILIO OREGONIUS

Papilio oregonius Edw. has a more northern range than *indra*, occurring from northern California into British Columbia. It seems to be limited to the area east of the Cascade Mountains. Holland (1930) says the specimen he figures, which is labelled "type," was collected by H. K. Morrison near Olympia, Wash. This is west of the Cascades, and the food plant of *oregonius* (see below) does not occur there. Also Leighton (1946) records it only from east of the mountains. So it is suspected that Morrison's specimen was mislabelled. Morrison collected in the vicinity of Mount Hood, Oregon, and he could very well have got this specimen near The Dalles, where *oregonius* does occur, and which is not far from Mount Hood.²

Collectors may confuse *oregonius* with *zelicaon*. Aside from the fact that the former is usually larger, the most evident distinction is the color of the abdomen. In *oregonius* the abdomen is predominantly yellow with only a narrow black stripe dorsally, a narrow, double black stripe ventrally, and, on each side, ventrolaterally, another narrow black stripe. The rest of the abdomen is yellow. In *zelicaon* the abdomen is predominantly black with one rather narrow yellow stripe down each side.

Oregonius is quite common along the Columbia River below Priest Rapids, about 30 miles east of Yakima, Washington. It has therefore not been difficult for the writer to study its life history. Attempts to get the females to oviposit in plastic cups, as was done with *indra*, failed. Since this is a larger species, a larger cage would be necessary. However, freshly deposited eggs and larvae in all stages were easily found on the food plant, and the life history was worked out from these.

Parasitism. — One chrysalid that had come from a larva collected when it was nearly full grown produced 72 small parasites. When discovered, these parasites were attacking other chrysalids and a full-grown larva in the same battery jar. The latter was quite irritated and was trying to shake them off. Examination with a binocular of the parasites attacking a chrysalid showed that they were not ovipositing but were feeding. A parasite would drill a small hole into the chrysalid with its ovipositor, then locate the hole with the tips of its antennae and feed for a few minutes on the fluid that was exuded. It would then locate the hole with the tip of its abdomen, insert the ovipositor and drill again, and then again feed. This process was repeated several times at the same hole.

²After this was written, the writer's attention was called to Edwards' statement in his *Butterflies of North America*, which is: "the type [of *oregonius*] was collected by Morrison near The Dalles, Oregon."

The parasites were all collected and examined, and of the 72, only 5 were males. This parasite has not been identified, but the writer (Newcomer, 1958) reported having reared *Apanteles lunatus* (Pack.), a braconid, from *P. oregonius* in 1916. This was at Wenatchee, Wash., and it is possible that these parasites are this species, which has been recorded (Essig, 1926) as parasitic on various species of *Papilio*.

Habits. — The newly hatched larva of *oregonius* eats its egg shell, and each molted larva eats the exuvium. Molting is the usual process, the skin splitting down the dorsum, the larva crawling out and detaching the head capsule with its thoracic legs. After resting for about 45 minutes the larva then turns around and eats the exuvium, holding the last remnant up in the air as it munches. This takes about five minutes, and the larva then rests again for a time before resuming normal feeding.

In two instances the exuvium was removed before the larva turned around. Not finding it, the larva again remained quiet for some time before going back to feeding on foliage. One of these larvae died a few days later. The other molted again, this time eating the exuvium, but it also died several days later. Whether this mortality was the result of not eating the exuvium cannot be said, as there was some mortality among these larvae from a disease.

Feeding is mostly on the foliage, the smaller larvae starting along the edge of a leaf, the larger ones at the tip and then devouring the entire leaf, which is linear in shape. Only the tender stems are eaten and the blossoms are avoided. Larvae are easily found on the food plant as they rest along the stems or on the leaves, not attempting to hide in any way. Pupation may occur on the larger stems or elsewhere and it is suspected that the hibernating chrysalids are in somewhat more protected places.

There are two broods of *oregonius* in Washington. Adults are flying in June and early July and again in August and September. Larvae collected about the middle of August will occasionally produce adults the same year, and these are probably from late first-brood adults. Most of them hibernate as pupae, however. Chrysalids brought in to room temperatures in March produced adults from early April until the middle of May, with three stragglers emerging June 22, July 19 and September 6.

At room temperature in August the duration of the various stages was as follows:

Egg	6 days
1st instar	3-7 days
2nd instar	4-6 days
3rd instar	4-6 days
4th instar	3-7 days
5th instar	10-16 days

The total duration of the larval period was 30-35 days. The pupal period, for those that hibernate, is about eight or nine months; for those emerging the same year, only 10-15 days.

DESCRIPTION

Papilio oregonius

EGG. --Spherical, flattened at base; pearly white, becoming yellowish; surface finely pitted. A reddish ring develops around the circumference as well as a reddish area at the micropyle. Later, the segmentation of the developing larva can be seen through the shell as grayish lines, and movement of the larva is easily observed with a Stereozoom binocular. Before hatching, the egg becomes quite black. Diameter, 1.5 mm.

LARVA. FIRST INSTAR. --Head and thoracic legs shiny black; body at first gray becoming dull black; a few yellow markings on segment 1 and a definite whitish band on 6 and 7, becoming yellowish; a row of tubercles on each side of the dorsal line, and two rows laterally; two slightly larger tubercles on segment 1. Length, 3-3.5 mm. when just emerged; becoming 5.5-6 mm. before molting; width at segment 1, 0.8 mm., tapering posteriorly; head 0.75 mm.

SECOND INSTAR. --Head shiny black with a central yellowish mark and a lateral yellowish stripe; body brownish black to black; a yellowish band along anterior edge of segment 1; a yellowish spot laterally; a small yellowish spot antero-dorsally on segment 2; bands on 6 and 7 more pronounced and light yellow; some yellowish or brownish markings on 11 and 12; a yellowish band on 13; thoracic legs black, prolegs black with whitish pads; osmeteria developed. Length, 6 mm.; width, 1.5-2 mm.; head, 1.1 mm.

THIRD INSTAR. --Head black, yellowish stripes larger; body blackish mottled with yellow and orange; segments 6 and 7 almost wholly yellow; tubercles black and smaller in relation to body size; legs as before. Length, 8-8.5 mm.; width, 2 mm.; head, 1.75 mm.

FOURTH INSTAR. --Head creamy white with black stripes; a central yellow area; body creamy white with numerous black horizontal stripes and spots; a bright yellow spot at base of each tubercle; a lateral lengthwise yellowish stripe just above prolegs; tubercles have disappeared; thoracic legs white with black spots and claws; prolegs yellowish, each with a black spot laterally. Length, 15 mm.; width, 2.5 mm.; head, 2 mm.

FIFTH INSTAR. --When full grown, head green with median and lateral elongated black spots and two longer black stripes; a yellowish area between the stripes; ground color of body light green, ventrally somewhat bluish green; this effect caused by alternate horizontal stripes of light blue and bright green, the green being on the anterior and posterior edges of each segment, the blue in the area between; segment 1 somewhat hooded in portion containing osmeteria, with two black spots where they are located; a black transverse band anteriorly and a narrower one posteriorly; segment 2, same but anterior band partially interrupted by six yellow spots; segments 3 to 12 have black median transverse bands in the green area interrupted by six yellow spots, two near dorsum, two lateral and two ventrolateral; segment 13 with a few black markings; thoracic legs bluish green, tipped with black and a basal black spot; prolegs bluish green, each with a black spot laterally. Length, 30 to 45 mm. or even 50 mm. when stretched out; width at thorax, 9.5 mm.; head, 3.5 mm.

PUPA. --Typical *Papilio* shape, protuberances on head and thorax only moderate; at first light green, wing covers bluish green, remainder yellow green with two streaks of yellow along dorsum. Some individuals remain a light bluish green, but most begin to show considerable gray coloration in a day or two, some even on the day of pupation. Final color usually light grayish brown, somewhat mottled, with ventral and lateral darker stripes; protuberances also darker. Length, 30-32 mm.; width at widest point, 8-9 mm.

VARIETY. --Two of the larvae reared had all of the colors intensified. This difference appeared in the fourth instar. The head was entirely green and black with no yellow. The body was a darker green with bluish areas more restricted. The spots were orange instead of yellow. These larvae were segregated from the others. One of them was 30 mm. long when full grown. The chrysalid was a light greenish with grayish wing covers and yellow markings on the dorsum. After 11 days it produced a male adult which seemed to be typical although a little smaller than normal. The other one died in the 5th instar.

Food Plants. — The primary food plant is *Artemisia dracunculus* L. This plant is usually called *dracunculoides*, but Abrams and Ferris (1960) have made this name synonymous with *dracunculus*. The latter name was given by Linnaeus in 1753 to a plant which occurs in Siberia and Eurasia. In 1814, Pursh described *dracunculoides* from the United States, indicating by the name that he thought it looked like *dracunculus*. This plant is the tarragon of commerce, used as a spice or flavoring for vinegar and pickles, and it is raised for that purpose in Europe. In Washington and Oregon it grows in clumps sometimes three feet high, in spite of being in areas where there is practically no rain all summer, and it may be found on rocky hillsides and canyon walls. Its green color contrasts strongly with the gray of other species of *Artemisia* which may be growing nearby. Llewellyn Jones (1951) gives the food plants in British Columbia as *Artemisia* sp. and *Umbelliferae* spp. Larvae were tried on carrot and parsley leaves at Yakima but they would not eat them. Emmel and Emmel (1963), however, report that larvae would feed on fennel. Whether the species ever chooses this as a food plant is not known.

The adult butterflies seem to feed exclusively on the blossoms of various thistles. These may include *Cirsium vulgare*, *C. undulatum* and *C. brevifolium*. Evidently the adult food is important, as *oregonius* has been found only where there are both tarragon and thistles.

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HYBRIDS BETWEEN PAPILIO MEMNON AND P. HELENUS AND BETWEEN P. MEMNON AND P. PROTENOR

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PAPILIO MEMNON LINNE is found in the southern part in Japan only while *P. helenus* Linne and *P. protenor* Cramer are distributed throughout most parts of Japan. The form of *P. protenor* in the area of Japan is tailed. The writer obtained three male F₁ hybrid butterflies between *P. helenus* female and *P. Memnon* male (Fig. 1a) and one male F₁ hybrid butterfly between *P. memnon* female and *P. protenor* male (Fig. 2a) in 1962. These data are presented here with one record of a crossing between *P. protenor* female and *P. memnon* male in 1961.

MATERIAL

The adult females and eggs of *P. memnon thunbergii* von Siebold were sent to the writer from Kyushu, Japan in spring of 1962 by Mr. H. Fukuda, Mr. I. Otsuka and Mr. A. Tanaka. The larvae from the above eggs, and eggs obtained from the above females were reared on Natsumikan (*Citrus natsudaidai* Hayata) and a large number of pupae were obtained. Many butterflies from these pupae were used for the experiments. The writer collected one *P. helenus nicconicolens* Butler at Ryusozan, Shizuoka-pref., Japan in May. The brood, N-40 from the above female, was reared on Kihada (*Phellodendron amurense* Rupr.) and many butterflies of this brood were used for the experiments. Some wild males of *P. protenor demetrius* Cramer collected in Nagoya by the writer were also used.

A few pupae and larvae of *P. memnon thunbergii* were sent to the writer from Kyushu by Dr. T. Shirozu in early summer of 1961. One male butterfly was obtained from the above larvae and used for the experiment. Brood R-54 of *P. protenor demetrius*, which originated from a female collected in Nagoya by the writer with the larvae reared on Inuzansho (*Fagara schinifolia* Engl.), was also used in 1961.

CROSSINGS

Three matings between *helenus* females and *memnon* males, 5 matings between *memnon* females and *helenus* males, and 3 matings between *memnon* females and *protenor* males were obtained by the method of hand-pairing in 1962. One mating between *protenor* fe-

male and *memnon* male was obtained by the same method in 1961. Eggs were obtained from 3 *helenus* females of the above first kind of mating, 3 *memnon* females of the second, one *memnon* female of the third and one *protenor* female of 1961. However, fertile eggs were only included among the eggs from three females of the first kind of mating, the female of the third and the female of 1961. Table 1 shows the egg fertility and hatchability of these matings and controls. An egg is yellowish white when laid, but if it starts to develop it becomes a mottled brown or a ring appears and either of these is used as an indication of fertilization. Therefore, if any embryo died at the very early age of development, the above indications may not appear. When an embryo is fully formed within an egg shell, the egg is always black. The egg fertility and hatchability of one mating between *helenus* and *memnon* were very high, although the same of other two matings of the same species were not so high. The low hatchability of one control mating of *helenus* may be the result of brother-sister mating.

REARINGS

Larvae of Brood N-40-1 (see Table 1) were reared on the following food plants: 24 on *Citrus* seedlings, 9 on *Natsumikan*, 11 on *Kihada*, and 14 on *Karasuzansho* (*Fagara ailanthoides* Engl.) All of the above plants are the natural food plants of *helenus* larvae. *P. memnon* larvae feed on *Citrus*, but they are not found on *Kihada* and *Karasuzansho*. The writer failed to rear *memnon* larvae on *Kihada* and *Karasuzansho* in a laboratory. Hybrid larvae grew well on *Citrus* and none died before the 5th instar stage, but some died at the 5th instar and many died by failing to molt at the prepupal stage. Only 4 good pupae were obtained and two male butterflies emerged (Fig. 1a). Many larvae died before the 5th instar in rearings on *Kihada* and *Karasuzansho*, especially failing to molt at the end of the 4th instar. Many also died by failing to molt at the prepupal stage. Only one good pupa was obtained from the larvae reared on *Kihada* and it emerged as a male. All larvae reared on *Karasuzansho* died without reaching their prepupal stages. Three and 10 larvae of Brood N-40-10 were reared on *Kihada* and *Citrus* respectively, but all of the larvae died at their young stages. Four larvae of Brood M-15-6 were reared on *Citrus*. One died at its prepupal stage and three pupae were obtained, but only one of them was fully formed and emerged as a male (Fig. 2a). Four larvae of Brood R-54-35 were also reared on *Citrus* (in 1961), and one good pupa was obtained. A male adult body was fully formed in this pupal shell, but it failed to emerge.

Noticeable differences were not observed in development rates of the above hybrid rearings. However, their pupae were very small in comparison with any of the laboratory reared parental species. Therefore, the hybrid butterflies obtained were very small.

LARVAL APPEARANCE

Larvae of the three parental species, which the writer used in this experiment, resemble closely each other in all stages of their development, and their mature larvae are all "orange-dog" type (Figs. 3b, 4b, 5b). However, it is possible to distinguish them in any stage of development. Appearances of the hybrid larvae of the above two kinds are generally intermediate between the parental species (Figs. 1b, 2b). The writer describes here a few striking characters. The ground color of young larvae of *memnon* is more greenish than in *helenus* or *protenor*. The ground color of both hybrids are greenish but they are not so prominently greenish as in *memnon*. The color of the two abdominal stripes of the 5th instar larvae of *memnon* is white and of other two species is brown. These stripes in both hybrids had whitish-brown color. The first stripe of *memnon* (the 4th and 5th abdominal segments) is wider than other two species. The second stripe of *memnon* (the 6th segment) is prominent only at lateral sides of the larvae, but it also appears clearly at the dorsal side in *protenor* and *helenus*. The shape of these stripes in the hybrid larvae are *protenor* or *helenus*-like according to the direction of hybridization.

Table 1. Papilio memnon hybridization

Parents		Eggs laid	Eggs fertile	Eggs blackened	Eggs hatched
Brood and female No.	Male No.				
N-40-1	M-14-1	67	63	62	61
N-40-10	M-14-3	23	21	-	13
N-40-13	M-14-2	29	9	3	0
M-15-6	R-68	11	11	11	4
R-54-35	M-8	5	5	5	4
N-40-4	N-40-9	14	12	9	1
N-40-12	N-40-8	75	71	68	66
M-19	M-18	44	43	43	42
M-17	M-16	58	58	58	57

N - helenus;M - memnon;R - protenor

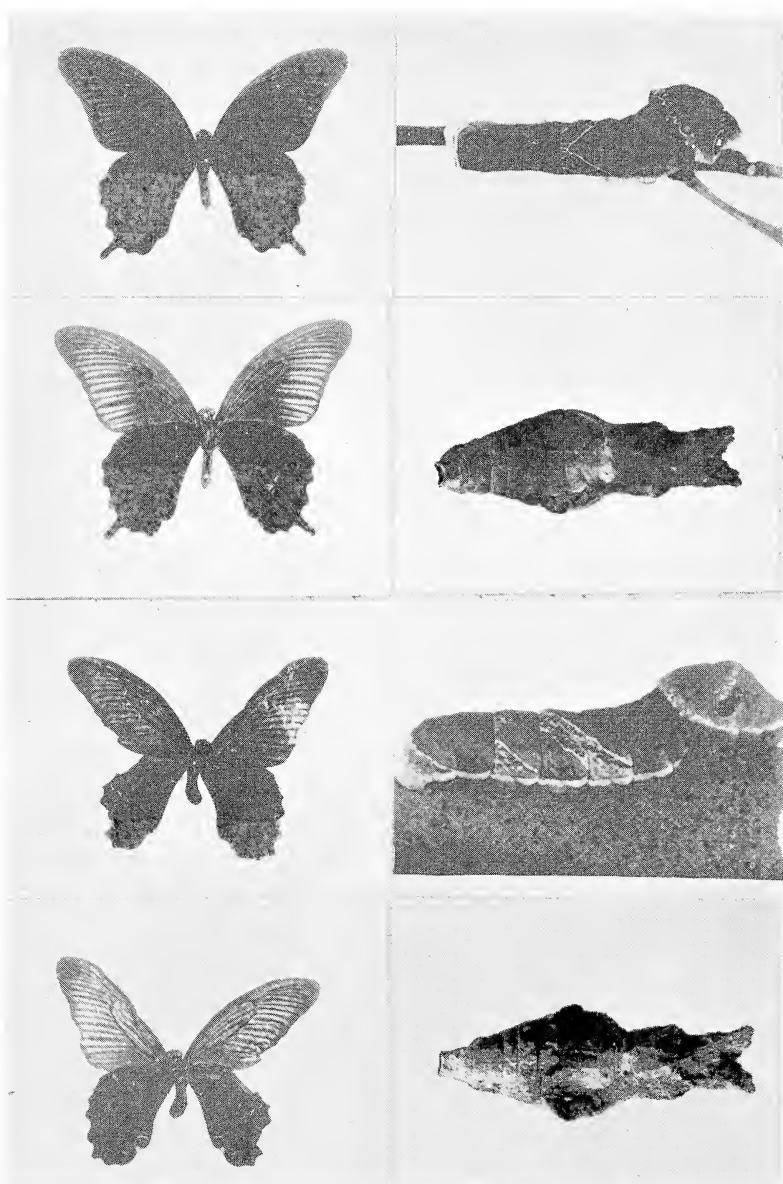


Fig. 1. *Papilio memnon* X *P. helenus*:
(a) adult male, upper side and under side (b) larva (5th instar) and (c) pupa.

Fig. 2. *Papilio memnon* X *P. protenor*:
(a) adult male, upper side and under side (b) larva (5th instar) and (c) pupa.

PUPAE

Pupae of the three parental species also resemble closely each other as do their larvae, but they are easily distinguished in the shapes of the head processes (Figs. 3c, 4c, 5c). The angle of the mid-ventral bend is the sharpest in *helenus*, and *memnon* pupae have the strongest look in their appearances. The hybrid pupae were intermediate in these characters between the parental species (Figs. 1c, 2c).

IMAGINES

The *P. memnon* male is tailless and has red patches at the base of the under side of the both wings (Fig. 3a). *P. helenus* and *P. protenor demetrius* both are tailed (Figs. 4a, 5a). *P. helenus* has white patches, which usually cover a part of cells Sc-R₁, R₂, and M₁ of the hind wing, and *protenor* (male only) has a white band in cell Sc-R₁ of the hind wing. Hybrids between *memnon* and *helenus* are tailed (Fig. 1a) and the hybrid between *memnon* and *protenor* are tailless (Fig. 2a). Neither the red patches of the base nor the white patches or band appeared on the wings of both kinds of hybrid.

Scattering of blue scales, which appear on the upper side of the hind wing of *memnon* and sometimes of *protenor* but does not appear on *helenus*, appeared on both kinds of hybrid. The band of the under side of the hind wing of *memnon* only, which is formed by the scattering of blue scales, appeared in both kinds of hybrid.

Seven crescent red patches appear on the under side of the margin of the hind wing of *helenus* and *protenor*; *memnon* has only a few patches of the same kind. The appearance of these patches in both kinds of hybrid were *memnon*-like.

DISCUSSION

The high egg fertility and hatchability of one mating between *helenus* and *memnon* suggests a close relationship between these two species. The fact that all of the eggs (16) from two matings between *memnon* and *protenor* started to develop may suggest also a close relationship between these two species. However, the fact that the large number of prepupae failed to molt in *memnon-helenus* hybrids may indicate that the relationship between these two species is not so close as the relationship between *protenor* and *helenus*, or between *helenus* and *polytes*, which were not lost in large numbers in one particular molting (Ae, 1962a, b and 1963).

The tail of the hind wing of many species of *Papilio* may be controlled by a similar gene(s). All local forms or subspecies of *helenus* have a tail and all forms of *memnon* male have no tail. However, most forms of *protenor* are tailless, even though the Japanese form does have a tail. Therefore, the genetic background of the tailed condition of *P. protenor demetrius* is not as stable as of *P. helenus*. This may be the reason that the hybrid between *helenus* and *memnon* has a tail,

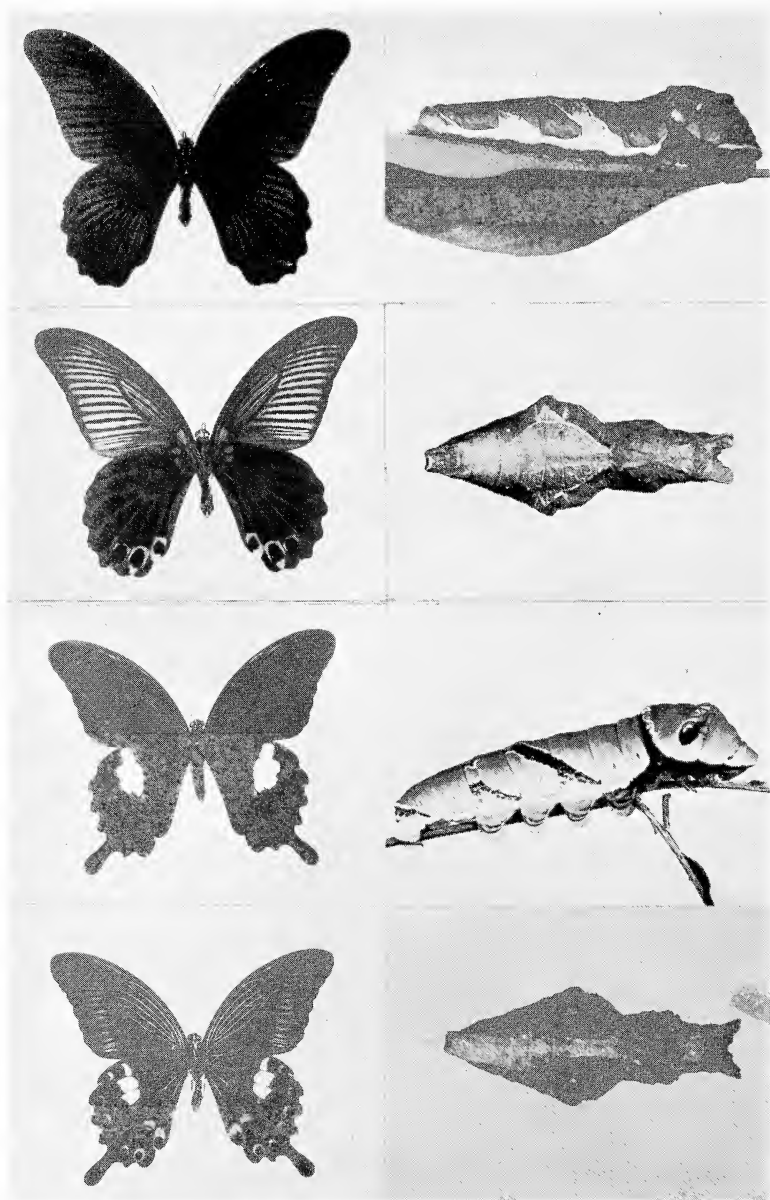


Fig. 3. *Papilio memnon*:

(a) adult male, upper side and under side (b) larva (5th instar) and (c) pupa.

Fig. 4. *Papilio belenus*:

(a) adult male, upper side and under side (b) larva (5th instar) and (c) pupa.

and the hybrid between *memnon* and *protenor* has no tail; the dominant-recessive relationship of the tailed phenotype reverses.

White patches (or band) appeared in hybrids between *protenor* and *helenus*, between *polytes* and *protenor*, and between *polytes* and *helenus* (Ae, 1962a, b and 1963), but these did not appear in the hybrids between *helenus* and *memnon* and between *memnon* and *protenor* (this paper). These facts may indicate that the genes, which control the white patches or the band of *helenus*, *protenor* and *polytes* may have the same origin and/or cooperative relations.

SUMMARY

1. Fertile eggs were obtained from three matings between *P. helenus* female and *P. memnon* male, and in matings between *P. memnon* female and *P. protenor* male and of its reciprocal by the method of hand-pairing.

2. The egg fertility and hatchability of one mating between *helenus* and *memnon* was very high. However, many individuals of this brood were lost at their molting at the perpetual stage.

3. The larvae of the above two kinds of hybrid were reared mainly on *Citrus*. Four pupae of *helenus-memnon* hybrids and one pupa of *memnon-protenor* hybrid were obtained. These pupae were very small

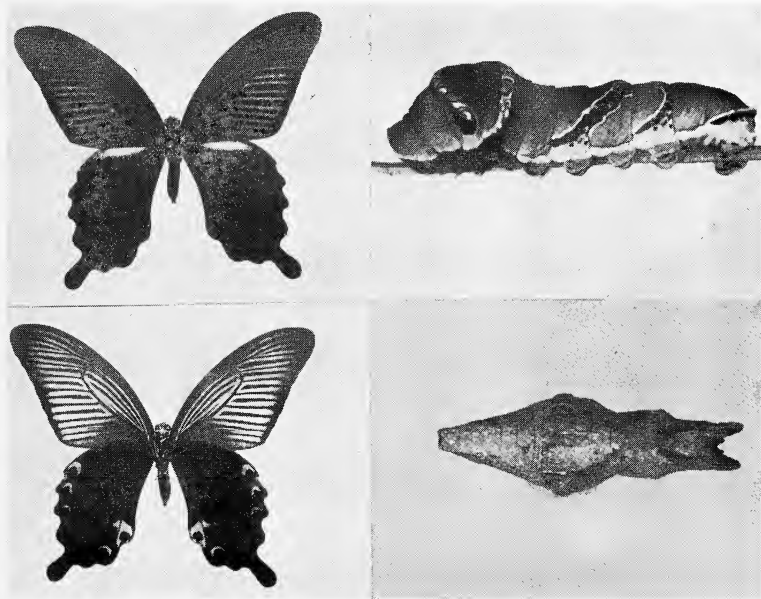


Fig. 5. *Papilio protenor*:
(a) adult male, upper side and under side (b) larva (5th instar) and (c) pupa.

in comparison with the parental species, although their developmental rates were the same.

4. Three male adults of *belenus-memnon* hybrids and one male adult of *memnon-protenor* hybrid were obtained.

5. Larval and pupal appearances of the above two kinds of hybrid were intermediate between the parental species in general.

6. The *belenus-memnon* hybrids were tailed and the *memnon-protenor* hybrid was tailless.

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NEW GYNANDROMORPH OF *COLIAS PHILODICE* FROM COLORADO

THOMAS C. EMMEL
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A SEXUAL MOSAIC of *Colias philodice* was taken at Big Spring Ranch, near Florissant, Teller County, Colorado, on July 25, 1960. The gynandromorph (Figure 1) has the wings on both sides largely male, with good development of the female marginal spotting pattern in the margins of the right forewing and to a lesser extent on the left forewing. The secondaries are entirely male in character. The specimen is in freshly emerged condition. This gynandromorph appears to be the first recorded from Colorado populations of *Colias philodice* Godart. (The yellow Colorado form is called *Colias eriphyle* by Brown *et al*, 1957 and *Colias philodice hageni* by Hovanitz, 1951).

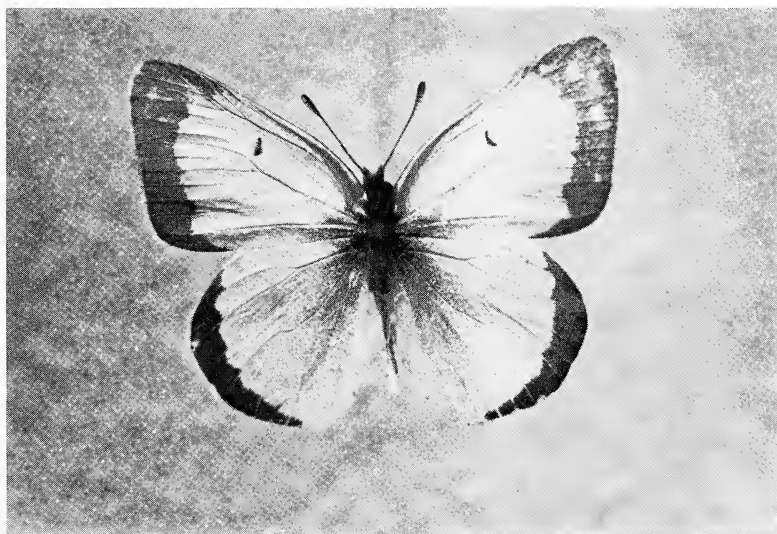


Figure 1. Sexual gynandromorph of *Colias philodice* from Colorado.

The secondary sexual characters in *Colias* species have been indicated to be independent of control by gonadal hormones circulating in the blood (review by Remington, 1954), as non-uniform distribution of color occurs in such partial gynandromorphs as the specimen reported here. The distribution of female characters in this specimen thus adds to the previous evidence that the chromosomal complement of each pigment-producing cell controls the female or male characters in wing pigmentation; that is, the sexual characters for pattern may be assumed to be under local intracellular control rather than general extracellular hormonal control. If present specimen developed as a male (with two X- chromosomes) and the loss of one X- chromosome occurred late in development of the wing imaginal discs, the tissue arising as a result would give rise to marginal female (XO) characters in the forewings of the imago.

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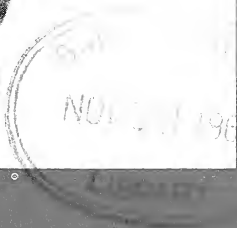
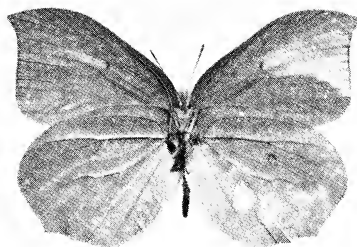
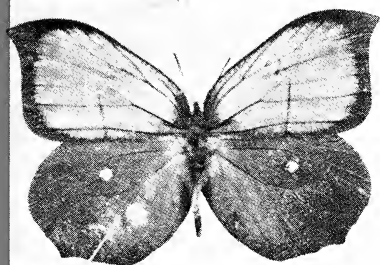
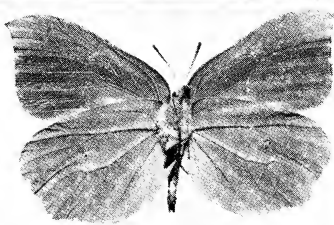
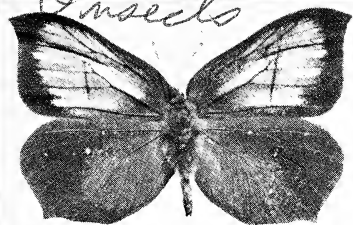
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THE HIDDEN WING-PATTERN OF SOME PALEARCTIC SPECIES OF GONEPTERYX AND ITS TAXONOMIC VALUE

YURI P. NEKRUTENKO

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THE WING-PATTERN of the lepidopterous insects is a marvellous phenomena, the biological importance of which is not yet entirely clear. The studies carried out by the late Dr. B. N. Schwanwitsch (1924) gave a starting-point to researches in this field of lepidopterology.

The fact of the existence of different wing-patterns is, of course, partly connected with the visual perceptions of a butterfly, and the biological importance of the pattern is partially mediated by vision. On the one hand, the pattern hides a butterfly from possible carnivorous enemies by its mimetic, or camouflage, similarity with other, "uneatable" insect, or natural objects; on the other hand, such a pattern can act as a visual sign of the species and assure this way, interspecific sexual isolation.

It is widely known that an insect is different from man in that it can see in the ultra-violet part of the sun spectra. This has forced some students to look on the butterflies "with a butterfly's eye." In 1957, G. A. Mazokhin-Porshnyakov studied optical characters of wings in some groups of butterflies and moths in UV-rays and found hidden patterns in some Pierid butterflies which he subjected to quantitative analysis.

This discovery confirms my previous suggestions on the biological value of the wing-pattern and of its significance as a taxonomic character.

The main task of this paper is to illustrate some examples of the usage of hidden patterns for taxonomic purposes.

MATERIAL AND METHOD

The method has been worked out by G. A. Mazokhin-Porshnyakov (1957). It consists in taking pictures on unsensitized (positive or color-blind) film when the lens of a camera is covered with black-glass filter transparent for the ultra-violet rays ($\lambda = 365 \text{ m}\mu$).

I used a 35 mm mirror camera Zenit-3 with a lens Industar-50. As a source of light, the mercury vapor lamp PRK-4 has been used.

Specimens of *Gonepteryx rhamni* L., *G. cleopatra* L. and *G. mahaguru (niphonica)* Vty.) served as materials for this work.

DESCRIPTION OF PATTERNS AND TERMINOLOGY

This paper deals with male hidden patterns only, because of the irregular nature of it in females. As a rule, the female's wing pattern shows that her wing absorbs ultra-violet rays over the entire wing surface. That is why all females are dark on pictures and why they are very much like the lower wing surface of a male. Perhaps, future students of this phenomenon ought to draw attention to this "half character" of hidden patterns.

Common to all three species is the presence in the upper surface of the forewing of a marginal dark zone (*zona opaca marginalis*), which broadness is maximal in *rhamni* and minimal in *cleopatra*. It is notable that in the costal-anal direction in all species, a narrow dark line appears for about half of the wing length (*linea opaca medialis*) (fig. 1).

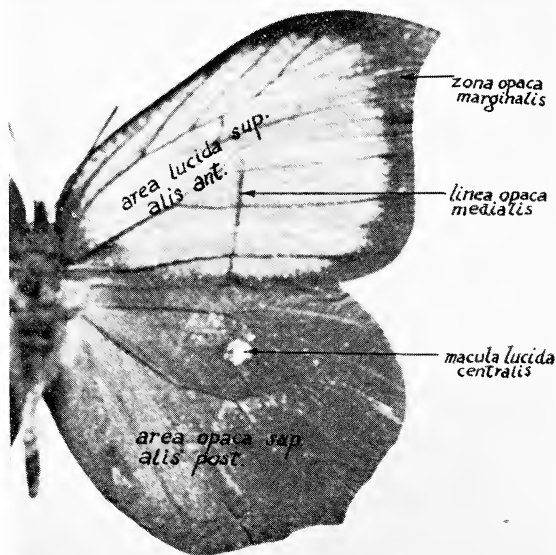
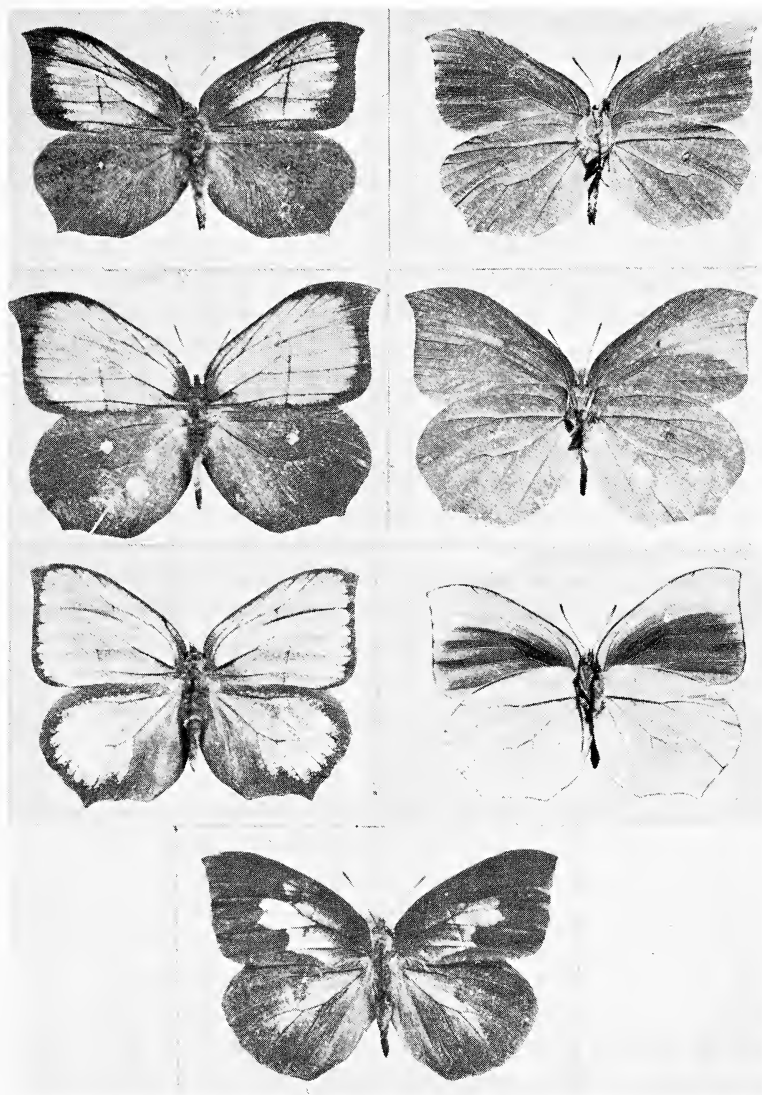


Fig. 1. Terminology of the hidden wing-pattern as illustrated by an example of *G. mahaguru niphonica* Vty - photographed with U. V. light.



Specimens of *Gonepteryx* photographed with U. V. light; upper side, right; lower side, left.

Fig. 2. *G. rhamni*

Fig. 3. *G. mahaguru nipponica* Vty.

Fig. 4. *G. cleopatra* L.

Fig. 5. *Zerene eurydice* Bdv. upper side only.

The upper surface of the hindwing absorbs ultra-violet far more than the forewing does. In *G. rhamni* and *mahaguru*, the entire surface is dark with the exception of a small central spot (*macula lucida centralis*). In *G. cleopatra*, this spot becomes very large and occupies nearly all the surface with the exception of a dark marginal zone that is similar to such a zone in the forewing.

KEY FOR THE IDENTIFICATION OF GONEPTERYX SPECIES

Upper surface of the male wing.

- 1(2) Dark marginal zone on the forewing broad, occupies more than $\frac{1}{4}$ of the whole wing-surface. Just a small bright spot on the hindwing *rhamni* L. (fig. 2)
- 2(1) Bright spot on the hindwing larger.
- 3(4) Dark marginal zone on forewing narrower than in *rhamni*, bright spot on the hindwing *mahaguru niponica* Vty. (fig. 3)
- 4(3) Dark marginal zone on the forewing very narrow; bright field on the central part of the hindwing *cleopatra* L. (fig. 4)

DISCUSSION

In my study of the wing-pattern of the *Pieridae*, I have presumed (1964) that it consists of a number of successively-deposited coloured layers which are fully presented and occupy the whole wing surface in the prototype, but which are presented in fragments only in actual specimens. It was a formal theory I made for the sake of having a point to work from in explorations. Then I draw my attention to the fact that fields of the wing which are black in visible light are also dark in the ultra-violet [*Zerene* (fig. 5) *Catopsilia* and other relatives of *Gonepteryx*]. Perhaps in these species in which the black elements of the pattern are absent in visible light but are present in the ultra-violet, we deal with reduced black patterns. The main problem is then to recognize the direction of evolutionary changes in this group.

ACKNOWLEDGMENT

My thanks are due to Dr. William Hovanitz who corrected the English text of the manuscript.

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AN EVAPORATIVE COOLING MECHANISM

IN *PHOLUS ACHEMON* (SPHINGIDAE)

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HEAT PRODUCTION DURING ACTIVITY in moths is well known (Adams and Heath, 1964). These insects are insulated against heat loss by a coat of dense pile (Church, 1960, and therefore, they may experience heat stress during activity in high ambient air temperatures (Heath and Adams, in press). However, some insects evaporate water by increased ventilation when under heat stress (Prosser and Brown, 1961). *Pholus achemon* (Drury) similarly increases the rate of ventilation under heat stress, but has an additional evaporative cooling mechanism.

Observations were made on a single male moth collected near Santa Barbara, California, in the spring of 1962. Although we have not had the opportunity to repeat these observations, the behavior was so striking and consistent as to appear worth reporting.

An iron-constantan thermocouple 0.3 mm. in diameter with long (one meter) and flexible leads was implanted in the thorax. Readings were made on a potentiometer with electronic reference junction, to the nearest $\frac{1}{2}^{\circ}\text{C}$.

Following implantation the animal was gently prodded. It began beating its wings with low amplitude, a process called shivering (Adams and Heath, 1964) or whirring (Dorsett, 1962). The animal heated at a rate of 7°C . per minute until a thoracic temperature of 39°C . was attained (Fig. 1). The moth then flew briefly, while the temperature rose to 40° . Upon alighting, it sat quietly and cooled. As cooling began a small drop of fluid appeared on the partially extended proboscis (Fig. 2). Rhythmic changes in the drop size indicated that the fluid was being drawn in and out of the mouth.

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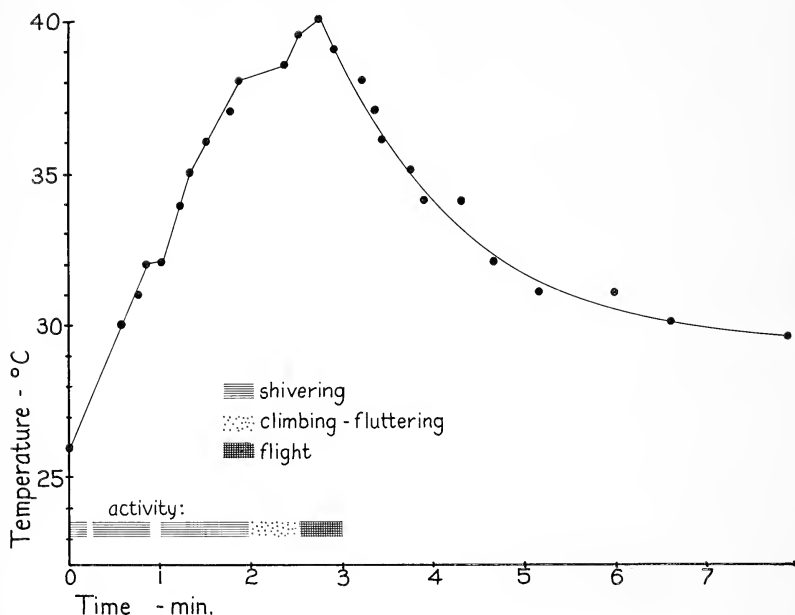


Fig. 1. Changes in thoracic temperature during activity in *Pholus achemon*. Ambient temperature 26°C.

In order to view this event in more detail the moth was heated artificially with an infra-red heat lamp held 30 cm. away. The drop appeared in four successive trials at thoracic temperatures of 40.5°, 41°, 40°, and 42.5°C. The drop size increased as the thoracic temperature rose, reaching a maximum estimated diameter of 3 mm. In each case the drop was withdrawn as cooling began. On the fifth trial no fluid was elicited; rather the animal retreated from the heat source to shade.

Observations on the rate of ventilation showed that vigorous and rapid movements began and continued during the period the temperature was high. A sudden increase in rate occurred at body temperatures of 40°, 41°, 40°, and 42°C. in successive trials, reaching maximum frequencies of 45 - 50 per minute.

Pholus also showed behavioral adjustments to localized radiant heat. At body temperatures above 42°C. the moth markedly changed its posture with respect to the heat lamp. The

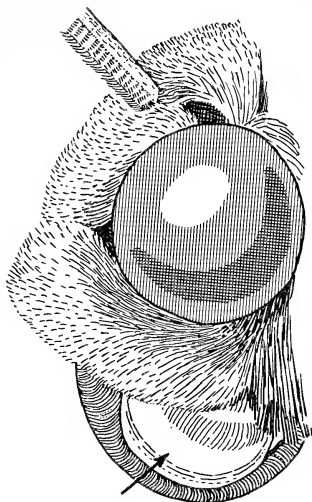


Fig. 2. The head of *Pholus achemon*, showing the location and relative size of the extended drop (arrow).

legs were extended, raising the body above the surface on which it was resting. The antennae were tucked under the wings and the body tilted so that it was shaded by the wings. This behavior was so effective in reducing the rate of heating that it was necessary to move the lamp closer to heat the insect further.

At very high body temperatures the moth moved out of the zone of radiation produced by the heat lamp. This response is called the "maximum voluntary tolerance" in reptiles (Cowles and Bogert, 1944). In six trials this occurred at 40.5°, 41°, 42°, 42°, 42.5°, and 42.5°C. (mean 41.8°C.).

Both pumping of fluid in and out of the mouth and abdominal hyperventilation appear to be effective means of cooling in *Pholus*. Two cooling curves obtained from *Pholus* differ from those of other sphingids, e.g. *Smerinthus* (Figure 3), in that the rate of heat loss is not directly proportional to the thoracic-ambient temperature difference. The cooling curve of *Smerinthus* is predictable from Newton's law of cooling, which states that the rate at which heat is lost to its surroundings by a body is proportional to the difference in temperature between them. Symbolically,

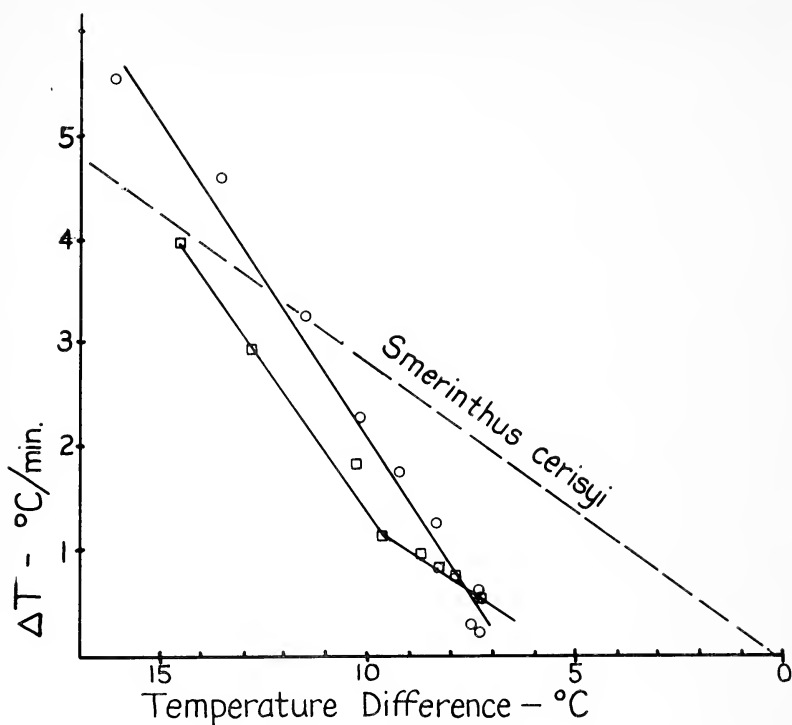


Fig. 3. Two cooling curves of *Pholus achemon*, compared with one of *Smerinthus cerisyi*. Delta T—rate of thoracic cooling; Temperature Difference—between thorax and ambient air.

$$\frac{dH}{dt} = c(t_2 - t_1)$$

where H is heat loss, t_2 the temperature of the hot body, t_1 the temperature of the surroundings, and c a proportionality constant. The higher-than-predicted heat loss in *Pholus* probably results in part from active evaporative cooling.

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A NEW SPECIES OF RIODINIDAE FROM MEXICO

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THE TUXTLA MOUNTAINS comprise a small cluster of volcanic peaks rising abruptly out of the broad gulf coastal plain of southern Veracruz, Mexico. Their maximum elevation is only about 5100 feet but this is sufficient for them to have well developed (though small) zones of montane vegetation, notably pine-oak forest and even cloud forest. These environments are isolated by ninety miles or more of coastal lowlands from their nearest equivalents in the Sierra Madre Oriental and form a distinct biotic "island."

In 1962 Mr. Gary Ross spent several months in these mountains, collecting and studying the butterflies with particular emphasis on their ecology. On his return he sent his captures in the Lycaenidae and Riodinidae to me for determination. Among the riodinids was a single worn male of a species that defied identification. It looked something like *Hamearis*, a genus that is not known from Mexico at all, but in view of its condition and uniqueness, plus the fact that Mr. Ross was contemplating a second visit to the area, I simply noted on the specimen that it was probably new and elaborated on it in a covering letter.

Apparently the first thing Mr. Ross did on his return to the Tuxtlas in 1963 was institute a search for this puzzling riodinid. By great good fortune—the kind of good fortune that comes to those who know what they are about and who work at it—he not only found additional specimens but succeeded in prying from the species the remarkable secrets of its early stages. These he chronicles in the paper following this one.

Subsequent study based on the long series obtained in 1963 has shown that this riodinid is a member of the genus *Anatole* Hübner, a close relative of *Hamearis*. Interestingly enough it bears no close relation to *Anatole agave* Doubleday, Westwood and Hewitson, the only member of the genus previously known from Mexico, but finds its affinities in the South American A.



Fig. 1. *Anatole rossi*, new species: A, male holotype, upperside; B, male holotype, underside; C, female paratype, upperside; D, female paratype, underside. All figures natural size. Photos by R. M. Fox.



Fig. 2. *Anatole zygia* Hübner. A, male, upperside; B, male, underside; C, female, upperside; D, female, underside. Photos by R. M. Fox.

zygia Hübner. It is tempting to suppose that this new species is a manifestation of the insularity of the Tuxtlas, a relict, endemic form; but other areas exist where its food plant occurs and the ecology is otherwise similar, and until they can be checked it would be decidedly premature to draw such a conclusion.

It is particularly appropriate, as well as a great pleasure, to name this new species in honor of its discoverer and biographer, Mr. Gary N. Ross.

ANATOLE ROSSI, new species

Male (Figs. 1A and B).

Vertex with rufous hair scales mixed with broader gray scales, narrowly white along the margins of the eyes; frons with rufous hair scales, becoming grayer and mixed with white ventrally, underlain by some gray scales centrally, white along the eye margins. Antennae black, the club tipped with orange (the last 4 to 6 segments). Palpi white laterally and ventrally, black dorsally. Thorax dark brown above, white below; legs white, the meso- and metathoracic pairs becoming gradually light gray distally, the mesothoracic pair with a gray-brown spot dorsally at the apex of the femur. Abdomen dorsally dark brown with a thin line of white scales along the posterior edge of each segment except the basal two (incomplete-lateral only-on the second), white ventrally, the demarcation between the two colors quite abrupt.

Upperside. Both wings dark brown, nearly black. Fore wing with two white spots in the cell, a small one just before origin of Cu₂ and a larger one just before origin of Cu₁; in cell Cu₂-2A a minute spot in extreme base and two slightly larger ones just beyond, the latter barely distad of the origin of Cu₂; a postmedian row of prominent quadrate white spots, widely disjunct at Cu₁, the apical part of the row nearly straight, arising a little beyond middle of costa and directed towards the end of Cu₂, the component spot in interspace between R₃₊₅ and M₁ smaller than the rest and displaced a little distad; the posterior part of the row straight in general trend, arising on inner margin at two-thirds and directed toward the costal end of the anterior part of the row (i.e., toward a point a little beyond middle of costa, this posterior part thus angled inward slightly), ending at Cu₁, the inner edge of the line at the origin of that vein; a subterminal row of subequal, smaller white spots parallels termen, the one in Cu₂-2A duplex; beyond these the ground color is black, at least posteriorly, with traces of a few white spots distad. Beginning distad of the postmedian spots and extending to termen the posterior veins are longitudinally broadly streaked with orange: veins Cu₁, Cu₂ and 2A always, and occasionally to some extent on the more costal veins as well. Fringe black, with white between the veins from apex to M₁, between M₃ and Cu₁ and between Cu₂ and 2A. Hind wing: the dark brown ground color extends distad from base at least two-thirds the length of the wing, crossed by an obscure, straight, whitish line from costa just before end of vein Sc diagonally across to middle of inner margin. The line is variably developed from light brownish and thin to pure white and thick, and tends to be stronger costad than elsewhere. The longitudinal orange streaks on the veins are strongly developed and proximally coalesce to form an orange subterminal band; distally the streaks separate a series of strong, thick, jet-black lunules, with minute traces of white spots both distally and proximally. Fringe black with white between the veins, broadest in M₃-Cu₁ and Cu₂-2A, narrower in the other interspaces.

Underside. Both wings dark gray, slightly brownish. Fore wing with all white markings as on upperside but larger, the postmedian row of spots connected to one another to form a band, disjunct as on upperside. The basal spots include an extra two in the base of the cell, the innermost of which extends costad of the cell; the dark areas between these spots are tinged reddish, particularly in the cell. The terminal white spots are much larger, appear as transverse white lines (in M₃-Cu₁ and Cu₂-2A) or thin crescents, convex outwards (in R₃-R₅-M₁), hence present in those interspaces where the fringe is white, absent from those where the fringe is black. Hind wing with the diagonal straight band heavier, pure white, distally delimiting a basal area where there are numerous reddish or grayish spots in a white field. A terminal series of oval white spots, gradually diminishing in size costad, each one rounded or even acute basally and flat distally; each encloses completely an oval brownish or jet black spot, the ones in M₃-Cu₁ and anterior half of Cu₂-2A small and punctiform, the others large, anteriorly nearly filling the white spots. Vein 2A prominently, but very narrowly, lined with bright orange distally.

Female (Figs. 1C and D).

Similar to the male, but with these differences: averaging slightly larger; all white markings above tend to be larger and sometimes to coalesce partly; the orange vein streaking is much more prominent and more extensive, particularly on the fore wing where it may affect the veins as far costad as M_1 ; sometimes the orange is proximally coalesced (as on the hind wing) at the level of the subterminal white spots, which the orange then surrounds without, however, obscuring them.

Male genitalia (Fig. 3). In comparison with those of Anatole zygia (Fig. 4), the male genitalia of A. rossi show the following differences: the uncus+tegumen is proportionately longer, the uncus lobes more rounded; the falces are longer, the vinculum less deeply sinuate in lateral view; the valva, though of about the same size, ends in a smaller, more acuminate hook; the saccus is shorter, more rounded; the penis is about the same size but is much more strongly downcurved, and the bend begins more proximally; the tip is abruptly constricted, not gradually and regularly so as in zygia; the cornuti consist of slender spines, thinner, longer and much more numerous than in zygia (their close compaction, as seen in the figure, is individual; in other specimens examined they are more regularly and widely dispersed); the anellus is considerably longer, the elongation occurring in the proximal part. Coincident with the change in sinuosity of the vinculum the valvae in rossi are nearly parallel to the dorsal edge of the uncus+tegumen, while in zygia they are rotated upward through an angle of roughly 52°.

The pregenital sternite (zygia, Fig. 5A; rossi, Fig. 5B) is similar in the two species, though that of rossi is more bell-shaped, with a stronger shoulder curve and lateral expansions at the base.

Female genitalia (Fig. 6A and B). Of an essentially simple type, the ductus bursae very long, sclerotized posteriorly (over a distance about four times its flattened width); corpus bursae with two feather-shaped signa, each ending anteriorly in a long, free spine with a serrated edge. Within the corpus bursae of the specimen examined were found three spermatophores, each nearly as long as the corpus bursae itself, arranged regularly inside and together completely filling the sac. Each spermatophore was rather bottle-shaped, its narrow end about the diameter of the ductus bursae and directed posteriorly. Two of them were intact, while the third was ruptured immediately opposite one of the signa.

Length of forewing. There are evidently three broods or flights represented in the series, one chiefly in June (recorded dates, 7 June to 4 July), one in late July and early August (recorded dates, 12 July to 13 August) and a third, represented by only one specimen taken 23 October 1962, Mr. Ross' first capture of the species. There appears to be a slight difference in size between the first two flights and they are accordingly recorded separately.

June flight: males, 15.5 - 19.5 mm.; mean, 18.3 mm.; standard deviation, 1.04 mm.; sample size, 15. Females, 18-23 mm.; mean, 18.9 mm.; standard deviation, 1.38 mm.; sample size, 13.

July-August flight: Males, 16-19 mm.; mean, 17.6 mm.; standard deviation, 0.93 mm.; sample size, 13. Females, 15-21 mm.; mean, 18.9 mm.; standard deviation, 1.56 mm.; sample size, 14.

The single October male measured 16 mm.

Holotype, male, 1/4 mi. ESE of Ocozotepec, 1950 feet, Tuxtla Mountains, Veracruz, Mexico, 1. viii. 1963, leg. Gary N. Ross.

Paratypes, 28 males and 27 females in all, all from the Tuxtla Mountains, Veracruz, Mexico, 1963 (except one, as noted), leg. Gary N. Ross, as follows:

Ocotal Chico: 1800 ft., 4. viii (1 male, genitalia slide C-993), 8. vi (4 females); 1900 ft., 7. vi (2 males, 2 females); 1/2 mi. SE or SSE, 1800 ft., 23. vi (1 male), 25. vii (1 male), 26. vii (1 male, genitalia slide C-984); 1/4 mi. E, 1900 ft., 9. vi (3 males, 2 females); 1/4 mi. SE, 1950 ft., 1. viii (1 male); 1/4 mi. N, 2100 ft., 11. vi (1 male, genitalia slide C-1001, +2 males), 15. vi (1 male), 18. vi (1 female); 1-1/4 mi. N, 2200 ft., 26. vii (1 female); 1 mi. S, 1800 ft., 7. vi (1 male, genitalia slide C-1003, +1 male); 1-1/4 mi. NE, 2600-2700 ft., 16. vi (1 female), 12. vii (1 male); 1/4 mi. SSE, 1700 ft., 8. vi (2 females); 1 mi. SSE, 1800 ft., 23. x. 1962 (1 male).

Ocotal Grande: 1900 ft., 19. vi (1 male), 4. vii (1 male); 1/4 mi. E, 1800 ft., 19. vi (1 female); 1 mi. E (elev. ?), 8. viii (1 male).

Ocozotepec: 2000 ft., 1. viii (3 males, 4 females); 1/4 mi. SE, 1950 ft., 1. viii (1 female, genitalia slide C-994, +5 females); 1/4 mi. ESE, 1950 ft., 1. viii (2 males, 3 females); 1-1/4 mi. NE, 2600 ft., 16. vi (1 male).

Mecayapan: 1-1/4 mi. E, 1025 ft., 13. viii (1 male).

Holotype and 3 male, 4 female paratypes, Carnegie Museum Entomology type series no. 503. Paratypes will be distributed to a number of institutions, including the United States National Museum, the American Museum of Natural History, the British Museum (Natural History). The remaining paratypes are in the collection of Mr. Ross.

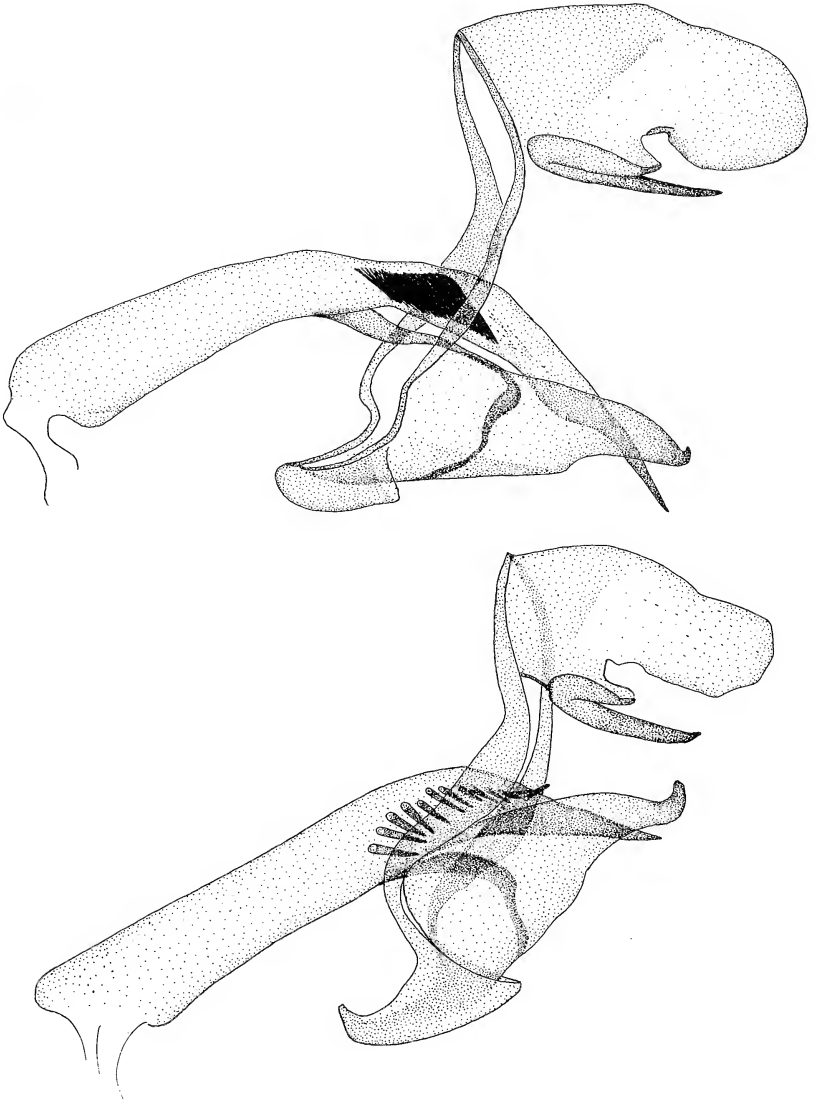


Fig. 3. *Anatole rossi*, new species. Male genitalia (paratype, slide no. C-993).

Fig. 4. *Anatole zygia* Hübner. Male genitalia (Benevides, Para, Brasil, October 1918, leg. S. M. Klages, slide no. C-990).

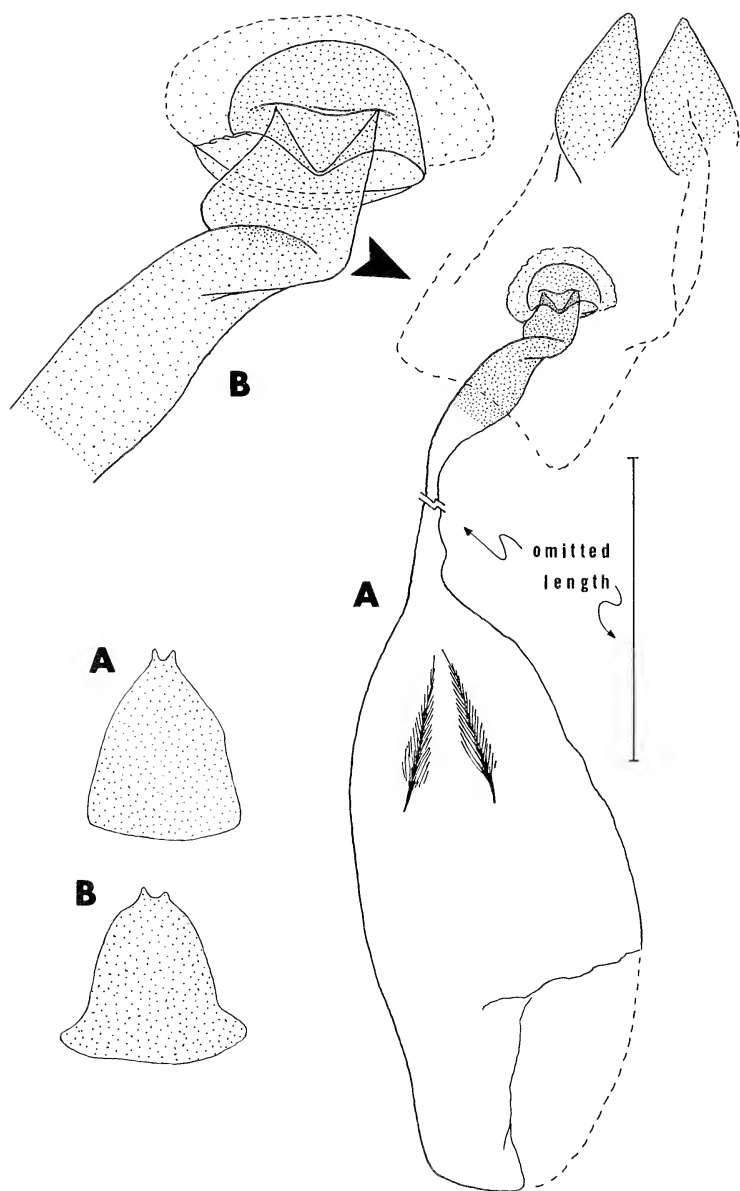


Fig. 5. Male pregenital sternites: A, *Anatole zygia*; B, *Anatole rossi*.

Fig. 6. *Anatole rossi*, new species. Female genitalia (paratype, slide no. C-994): A, papillae anales and bursa copulatrix (an undifferentiated portion of the ductus bursae is omitted as shown), B, enlarged view of the posterior part of the ductus bursae and ostium bursae.

Remarks. As was noted in the introductory remarks *Anatole rossi* is most closely allied to *A. zygia* Hübner, the type of the genus and a species known only from South America. The two are very distinct, however, as the following comparison shows. In *A. rossi* the hind wing is evenly rounded, not tornally produced as is true of *zygia*; the orange vein streaking of *rossi* is represented in *zygia* only on the fore wing and only on vein 2A, where it occurs in the form of a small, round (not elongate) orange spot centered on the vein subterminally. On the hind wing *zygia* has a discal patch of yellow orange without counterpart in *rossi*, and also in *zygia* the entire area posterior to Cu₂ from one-third out from base to the termen is pure white save for a few isolated subterminal black spots: also without counterpart in *rossi*. The postmedian and subterminal white spots are smaller and obsolescent in *zygia* and the postmedian row has a slightly different configuration than in *rossi*. In the latter the spot in M₃-Cu₁ is displaced very slightly basad while in *zygia* it is displaced a little distad (in both cases, relative to the trend of the anterior part of the series). On the underside the ground color of *zygia* is mostly orange on the fore wing (instead of the gray-brown of *rossi*) and *zygia* has most of the hind wing white.

The only other *Anatole* in Mexico is *A. agave* Godman & Salvin, which differs from both *rossi* and *zygia* in so many ways (e.g., in the much shorter palpi) that it possibly should be referred to a different genus altogether.

A. rossi exists in two forms: the "normal" form (as illustrated) which is the commoner of the two by far; and a variant form differing as follows: perhaps slightly larger; orange vein streaking extending much farther costad (to M₁ on fore wing; to Rs on hind wing), the streaks proximally more heavily conjoined; fore wing with postmedian white spots larger, tending to fusion. The form has been noted only in the June flight and it occurs then along with "normal" specimens. Genitally there is no difference whatever between this form and the "normal" form and in response to an inquiry of mine on the subject, Mr. Ross said that there was no field evidence, either in behavior or in ecology, that would suggest that more than a single species was involved.

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LIFE HISTORY STUDIES ON MEXICAN BUTTERFLIES

II. EARLY STAGES OF *ANATOLE ROSSI* A NEW MYRMECOPHILOUS METALMARK

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DURING THE FALL of 1962 and the summer of 1963, I collected a new species of metalmark on the slopes of Volcán Santa Marta (Sierra Tuxtla, Veracruz, Mexico). This species, *Anatole rossi* Clench, is described in this same issue (Clench, 1964). Descriptions of the larva with brief observations on its ecology and ethology are given here; the intimate association between this larva and ants of the species *Camponotus abdominalis* Fabr. (Formicidae: Formicinae) will be described at a later date.

Terminology is based on that of Fracker (1915) and Peterson (1948).

Measurements and color descriptions are based on living material (larval measurements are based on individuals in a state of rest).

Drawings of the larval lateral tubercles and "honey glands" as well as the pupal gland (figs. 6 & 7) were made from both gross dissections of and longitudinal cross sections through larvae and pupae. All longitudinal sections were dehydrated in ethyl alcohol and cleared in xylene. The larval metathoracic and abdominal sections were imbedded in tissuemat and sectioned at 10 microns. The metathoracic section was stained with Grote's hematoxylin and eosin Y and the larval abdominal section was stained with Delafield's hematoxylin and eosin Y. The pupal metathoracic section was imbedded in tissuemat, sectioned at 20 microns, and stained with Delafield's hematoxylin and eosin Y.

All drawings are by the author.

ACKNOWLEDGEMENTS

I would like to express my appreciation to the following people: the Department of Entomology and its head, Dr. L. D. Newsom for sponsoring the trip to Veracruz; Mr. and Mrs. J. M. Lind (affiliated with the Instituto Lingüístico de Verano, Mexico, D.F. and presently living in Ocotil Chico, Veracruz) for living accommodations and the wonderful hospitality that

EGG: Fig. 3F. (Measurements and duration are based on 21 specimens.) Dimensions--height, 0.4-0.5 mm.; width, 0.6-0.7 mm. Duration of stage, 8-9 days.

Dorso-ventrally flattened, slightly concave on both the dorsal and ventral surfaces. Entire outer surface (except the region surrounding the micropyle) with fine, elevated, hexagonal reticulations; small villus-like processes protruding from the corners of all hexagons.

Color milky light green, acquiring a slight yellowish tinge two days before the larva emerges.

Oviposition is on the undersurfaces of the new leaves of *Croton repens* Schlecht. (Euphorbiaceae). A bush reaching a maximum height of 2 to 2 1/2 feet and found commonly in the open pine forest on the leeward slope of Volcan Santa Marta. Eggs are deposited singly, usually one per plant, and often (but not exclusively) on leaf veins. Females appear to be selective in regards to oviposition sites: I never have seen any ovipositing on the mature, robust, densely foliate plants which were so common in the area but have noticed that they always choose the very small (usually plants below 7 inches in height), sparsely foliate plants. Perhaps one explanation for this fact is that the new leaves of the mature crotons seem to be much more pubescent than the new leaves of the younger and smaller plants. When these densely pubescent leaves were offered to experimental first, second, and third instar larvae, the larvae experienced difficulty in getting their mouth parts through the hairs in order to feed on the succulent tissues beneath. In fact, they all died, presumably from starvation. Therefore, there seems to be some survival value in the female's avoidance of the more mature plants.

It is interesting to note that Zikan (1953) pictures and describes the egg of *Anatole epone* (Godt.), which does not correlate well with the egg of *A. rossi*, and records the food-plant as *Croton lundianus* Mull.

FIRST INSTAR LARVA: Fig. 1A. (Measurements and duration are based on 15 specimens.) Subsequent to egg hatching-- length, 1.4-1.5 mm.; width, 0.2-0.3 mm.; head diameter, 0.32-0.33 mm. Termination of stadium-- length, 2.5-2.6 mm.; width, 0.7-0.8 mm. Duration, 4-5 days.

Head (fig. 2D) slightly wider than prothoracic segment; dark brown with fine, finely serrate, tan setae on lower portion; ocelli dark brown.

Body dorso-ventrally compressed with segments extended laterally giving the larva a flattened "scalloped" appearance. Prothoracic segment with a pair of very slight dorso-anterior expansions (rudiment of the hood described below) concolorous with the body. Penultimate segment (the fused ninth and tenth abdominal segments) slightly smaller than the other body segments and appearing button-like (the penultimate segment retains this shape throughout all instars and will not be discussed hereafter). Spiracles elliptical and inconspicuous (prothoracic pair located on the suprapedal lobes).

Paired primary setae (0.1-0.2 mm. in length, stout, white, and simple) on segments in the following arrangements: prothoracic (cervical shield)-- 1 dorsal-subdorsal, 1 lateral; meso- and metathoracic-- 1 dorsal and 1 subdorsal; first to seventh abdominal-- 2 dorsal (1 anterior, 1 posterior); eighth and ninth abdominal-- 1 dorsal and 1 subdorsal; tenth abdominal-- 1 dorsal; in addition to the above, the first to the ninth abdominal with 1 on the dorso-anterior portions of the lateral segmental expansions and the tenth abdominal with 1 on the median portion of the lateral segmental expansion. Paired secondary setae (approximately 0.8-0.9 mm. in length on the prothoracic segment and approximately 0.3-0.4 mm. in length on all other segments), fine, serrate, and white (fig. 4M) on segments in the following arrangements: prothoracic-- 4 arising from the dorso-anterior projection of the cervical shield (3 of which project fan-like anterior, the fourth projecting slightly laterally), 1 on the lateral expansion and 1 on the suprapedal lobe; mesothoracic to the ninth abdominal-- 3 arising from the lateral expansions and projecting laterally and 1 or 2 on the suprapedal lobes; tenth abdominal-- 3 arising as the above but projecting fan-like posteriorly and 1 or 2 on the suprapedal lobe. Setal maps (fig. 5A) illustrate the above arrangements.

Legs concolorous with the body. Prolegs concolorous with the body and with the crochets arranged in an unordinal mesoserries; ventral prolegs each with a small fleshy protuberance separating the 4 mesal crochets from the 2 lateral crochets (fig. 4A); anal prolegs each with a similar protuberance but only a mesal mesoserries of 4 crochets present (fig. 4G); prolegs each with 1 or 2 small, simple, white setae arising from the planta.

Body uniform light yellow (turning greenish the day prior to the first molt) with a supraspiracular row of faint black dots on the second to the seventh abdominal segments.

Larvae emerge from the depressed micropyle, leave the egg intact and crawl (still on the undersurface of the leaf) to an angle between two veins (usually between the midrib and its first branch). They then spin a silken mat upon which they rest during the non-feeding periods, aligning themselves with their heads directed inward toward the petiole. Feeding is on the same leaf; larvae consume small bits of tissue from the inner portions of the leaves, the margins hardly ever being eaten. Leaves, therefore, soon acquire a holey appearance and serve as a landmark for the entomologist wishing to secure larvae.

SECOND INSTAR LARVA: Fig. 1B. (Measurements and duration are based on 13 specimens.) Beginning of stadium-- length, 2.6-2.7 mm.; width, 0.7-0.8 mm.; head diameter, 0.52-0.53 mm. Termination of stadium-- length, 4.0-4.4 mm.; width, 0.9-1.0 mm. Duration, 4-5 days.

Head dark brown with numerous fine, finely serrate, tan setae concentrated on the lower portion; ocelli dark brown. Head is only slightly retractable beneath prothoracic segment.

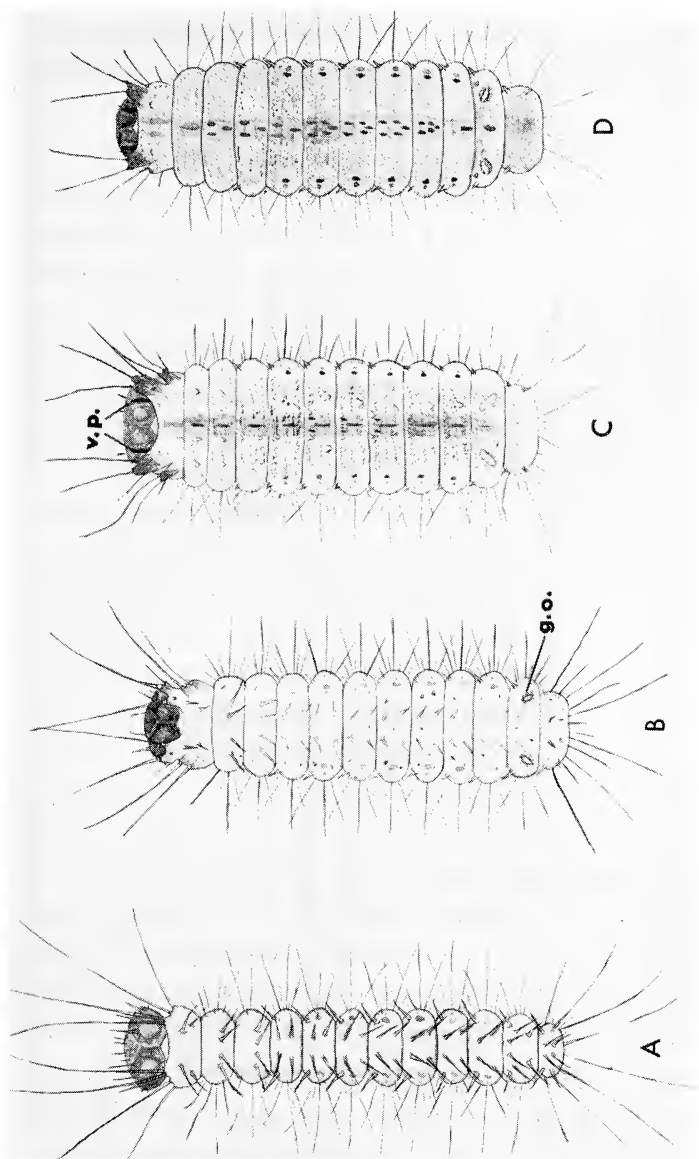


Fig. 1. A. First instar larva (39X). B. Second instar larva (15X); g.o.= gland orifice. C. Third instar larva (8X); v.p.=vibratory papilla. D. Fourth instar larva (5X).

Body dorso-ventrally compressed and extended laterally as before. Three thoracic segments expanding successively to the 0.7-0.8 mm. wide first abdominal segment (this type of arrangement continues throughout all instars and will not be mentioned hereafter). Prothoracic segment expanded dorso-anteriorly into two pairs of horn-like projections (one of which is more dorsal and larger than the other) that overhang the head slightly and that are whitish and tipped with dark brown markings; both pairs of horns composed of 2 small branches. Metathoracic segment of preserved larva shows a single pair of inconspicuous external slits set at a 45° angle to the middorsal line and situated on the posterior section of the lateral segmental expansion. Eighth abdominal segment slightly smaller than the preceding abdominal segments and with a pair of slight rectangular elevations set at a 45° angle to the middorsal line and situated slightly posterior to the spiracle (fig. 1B, g. o.). (I should mention here that these two pairs of structures, one on the metathoracic segment and the other on the eighth abdominal segment, may be present in the first instar larvae. Microscopic examination of first instar larvae indicates that there is the possibility that these structures are present in that stage although the actual structures were not discernable) Spiracles inconspicuous as before.

Primary setae in the same arrangement as before. Secondary setae on the prothoracic segment arranged in the following manner: 2 long (0.7-0.8 mm. in length), fine, serrate, and white arising from the dorsal-most horn (1 per branch of horn) and 2 shorter (0.3-0.4 mm. in length) arising from the ventral-most horn (1 per branch of horn). All other segments with secondary setae slightly more numerous than before.

Legs as before. Prolegs concolorous with the body and with the crochets arranged in a biordinal meseries; ventral prolegs each with a protuberance as before separating the 6 mesal crochets from the 6 lateral crochets (fig. 4B); anal prolegs each with a similar protuberance but only a mesal meseries of 8 crochets present (fig. 4H); prolegs each with 1 or 2 small, simple, white setae arising from the planta.

Body ground color light yellowish green. Middorsal, longitudinal band, approximately 0.2 mm. in width, more greenish than ground color; dark color of blood in heart visible through the cuticle giving the impression of a discontinuous middorsal stripe. Supraspiracular row of small dark brown dots on the second to the seventh abdominal segments now very conspicuous. A few short papillae and granulations, concolorous with body, scattered on all segments.

Ecdysis occurs on the silken mat mentioned earlier; the exuviae are never eaten. Occasionally the old leaf is abandoned after ecdysis and another leaf chosen as the new resting site for the subsequent stadium.

In regards to the above mentioned slits and elevations, it appears that they are rudiments of the lateral organs and the honey glands that will be described below.

THIRD INSTAR LARVA: Fig. 1C. (Measurements and duration are based on 12 specimens.) Beginning of stadium- length, 5.1-5.4 mm.; width, 1.0-1.2 mm.; head diameter, 0.77-0.78 mm. Termination of stadium- length, 7.0-7.9 mm.; width, 2.1-2.7 mm. Duration, 5-6 days.

Head as before.

Body shape as before. Prothoracic segment as before but horns now much more conspicuous; a pair of heavily sclerotized, chitinous (a chitosan sulfate test proved positive), dark brown, lance-like papillae approximately 0.2-0.3 mm. in length and henceforth termed "vibratory papillae," explanation given below (fig. 1C, v. p.; detail, fig. 5F); each papilla is socketed and is attached internally to a small tendon (fig. 5F, t); this tendon serves as the point of insertion for two muscles, one of which (fig. 5F, m₂) originates on the median section of the post occipital ridge of the head capsule and the other (fig. 5F, m₁) on the posterior margin of the prothoracic segment. Metathoracic segment with a pair of slits situated on the anterior part of the lateral segmental expansion; a small finger-like projection or organ tipped with a rosette of approximately 12 fine, trichose, white setae can be everted from each of these slits especially following tactile stimulation but often without any such provocation. Eighth abdominal segment with a pair of fully developed secretory glands. Spiracles now evident as faint yellow dots.

Primary setae now appearing as stout, short papillae; subdorsal pair on the eighth abdominal segment are now incorporated into the papillae fringing the orifices of the secretory glands (see below). Secondary setae more numerous than before; those on the dorsal-most pair of horns being 0.8-0.9 mm. in length (fig. 4N), the others being slightly shorter. Setal maps (fig. 5B) illustrate the arrangement of setae.

Legs as before. Prolegs concolorous with the body and with the crochets arranged in a biordinal meseries; ventral prolegs each with a protuberance as before separating the 14 mesal crochets from the 6 lateral crochets (fig. 4C); anal prolegs each with a similar protuberance but only a mesal meseries of 22 crochets present (fig. 4I); prolegs each with 1 or 2 small, simple, white setae and approximately 2 or 3 small papillae arising from the planta.

Body ground color light green. Middorsal band approximately 0.4 mm. in width and more greenish than ground color; band with 3 very slight wrinkles, each wrinkle with tiny, dark brown papillae (papillae on the thoracic and penultimate segments not confined to these elevations but more or less merged forming small patches); middorsal band with 2 lateral, dark green stripes on the anterior sections of the third, fourth, and fifth abdominal segments. Supraspiracular row of black dots as before. Papillae and granulations on the lateral segmental expansions dark brown, otherwise whitish except on previously described wrinkles; numerous papillae fringing the orifices of the secretory glands.

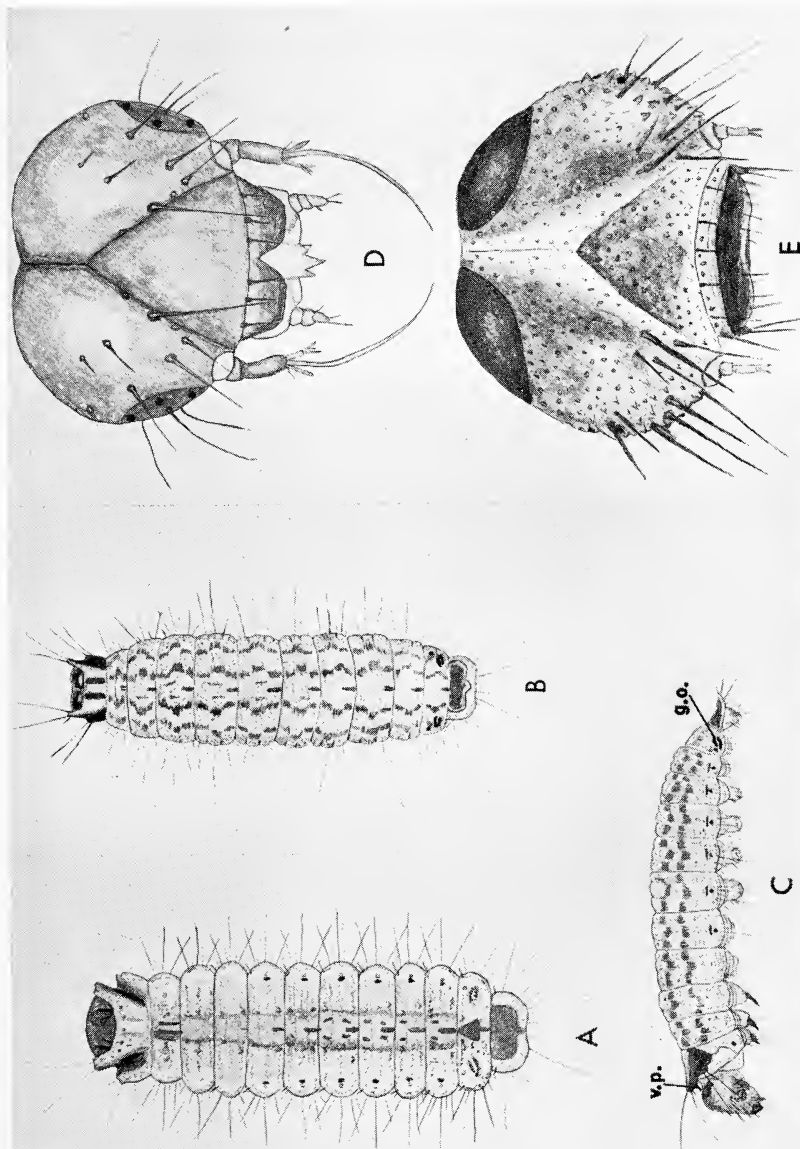


Fig. 2. A. Fifth instar larva (4X). B. Sixth instar larva (3X). C. Sixth instar larva, lateral view (3X); g.o.=gland orifice, v.p.=vibratory papillae. D. Head of first instar larva (200X). E. Head of sixth instar larva (20X).

The above mentioned "vibratory papillae" are so named because when a larva is disturbed, these structures vibrate very rapidly in an up and down manner. The relationship between the above mentioned secretory glands, tubercles, and these structures is not understood. The fact that they first appear in the same instar as that in which the glands and tubercles become functional (at least in this species as this correlation has not been made previously) would lead me to think that there may be a definite connection between the three. Bruch (1926) working with *Hamearis epulus signatus* Stich, an Argentine riodinid, states that the papillae must have some relationship with the secretory glands on the eighth abdominal segment. Bourquin (1953) states that in *Hamearis susanae* Orfila, another Argentine species, the attending ants (*Camponotus punctulatus* Mayr) frequently touch the vibrating structures and that this probably has some connection with the secretions produced from the glands on the eighth abdominal segment.

The above mentioned organs occurring on the metathoracic segment seem to be similar to the pair of lateral organs or tubercles which occur on the eighth abdominal segment of many of the Lycaenidae (see Clark and Dickson, 1956 and Hinton, 1951 for summaries). This is the first mention of any such structures occurring on a thoracic segment. See under SIXTH INSTAR LARVA for detailed morphological descriptions of these organs.

The above mentioned secretory glands on the eighth abdominal segment appear to be similar to the single honey gland of many of the Lycaenidae (see summaries by the above mentioned authors) and comparable to the pair of honey glands reported as occurring on the larvae of several of the Riodinidae: *Theopoe eudocia* Hew., *T. foliorum* Bates, and *Nymphidium molpe* Hub. (Guppy, 1904), *Hamearis epulus signatus* Stich. (Bruch, 1926) and *H. susanae* Orfila (Bourquin, 1953). See, also, under SIXTH INSTAR LARVA for detailed morphological descriptions of these organs. These honey glands secrete a clear, watery substance ("honey dew") which is sought by ants (*Camponotus coruscus* Fr. Smith and *C. abdominalis* Fabr.) As stated in the beginning, there is a very complex symbiotic relationship between the worker ants of the second mentioned species and the caterpillars of *A. rossi*, a subject which will be described in detail elsewhere.

From this instar on through the sixth, larvae are found at the bases of the crotons in tiny temporary burrows or "pens" constructed by the ants. The caterpillars spend the daylight hours in these confines but crawl out and up onto the leaves of the plants during the night in order to feed. As the larvae increase in size, they do not limit themselves to feeding from the inner portions of the leaves but instead, devour practically the entire leaves (excluding the veins).

FOURTH INSTAR LARVA: Fig. 1D. (Measurements and duration are based on 9 specimens). Beginning of stadium- length, 7.9-9.4 mm.; width, 2.2-3.1 mm.; head diameter, 1.10-1.16 mm. Termination of stadium- length, 10.1-11.0 mm.; width, 3.5-4.0 mm. Duration, 8-9 days.

Head dark brown with numerous fine, serrate, ant setae and papillae on lower portion.

Body shape as before. Prothoracic segment with horn-like projections now very conspicuous and bearing a remarkable resemblance to the Fifteenth Century Horn Dress; these structures project over the head such that from a dorsal view, the head of a resting individual is almost entirely obscured. Spiracles as before.

Primary setae as before; the subdorsal pair on the eighth abdominal segment is now indistinguishable from the numerous papillae fringing the orifices of the honey glands. Secondary setae are more numerous than before.

Legs as before. Prolegs concolorous with the ground color and with the crochets arranged in a triordinal mesoserries; ventral prolegs each with a protuberance as before separating the 26 mesal crochets from the 8 lateral crochets (fig. 4D); anal prolegs each with a similar protuberance but only a mesal mesoserries of 42 crochets present (fig. 4J); prolegs each with approximately 4 setae and approximately 6 or 7 small papillae arising from the planta.

Body ground color as before; faint yellow shading at the segmental junctures. Middorsal longitudinal band, approximately 1.0-1.2 mm. in width at the widest point but contracting slightly at the segmental junctures, slightly lighter than the ground color; band with wrinkles more evident and with papillae more numerous than before and with dark green markings; prothoracic segment with a single pair of lateral, rectangular stripes; meso- and metathoracic segments each with a single median, rectangular stripe (caused mainly by the circulating blood beneath the cuticle); first six abdominal segments each with a double pair of lateral dots and a single median dot, the five markings situated in a horse-shoe arrangement; seventh and eighth abdominal segments each with a single median, longitudinal stripe. (It should be mentioned here that some specimens exhibited slight variations from the above descriptions, e.g., some had the above described markings more or less fused, but generally the pattern was consistent). Supraspiracular row of dots as before. Papillae and granulations more numerous than before.

FIFTH INSTAR LARVA: Fig. 2A. (Measurements and duration are based on 8 specimens). Beginning of stadium- length, 12.0-13.4 mm.; width, 3.7-4.5 mm.; head diameter, 1.93-2.10 mm. Termination of stadium- length, 14.9-16.6 mm.; width, 4.1-4.9 mm. Duration, 23-25 days.

Head as before but with a light tan border near the epicranial suture. Setae finely trichose but not as trichose as those on the body. Papillae more numerous than before.

Body not as dorso-ventrally flattened as before. Eighth abdominal segment with glands bordered basally with 2 elevated, crescent-shaped, glossy black ridges. Spiracles as before.

Primary setae as before. Secondary setae more numerous than before and now finely trichose or pilose (fig. 40); those on the prothoracic horns approximately 1.2-1.4 mm. in length, all others being slightly shorter.

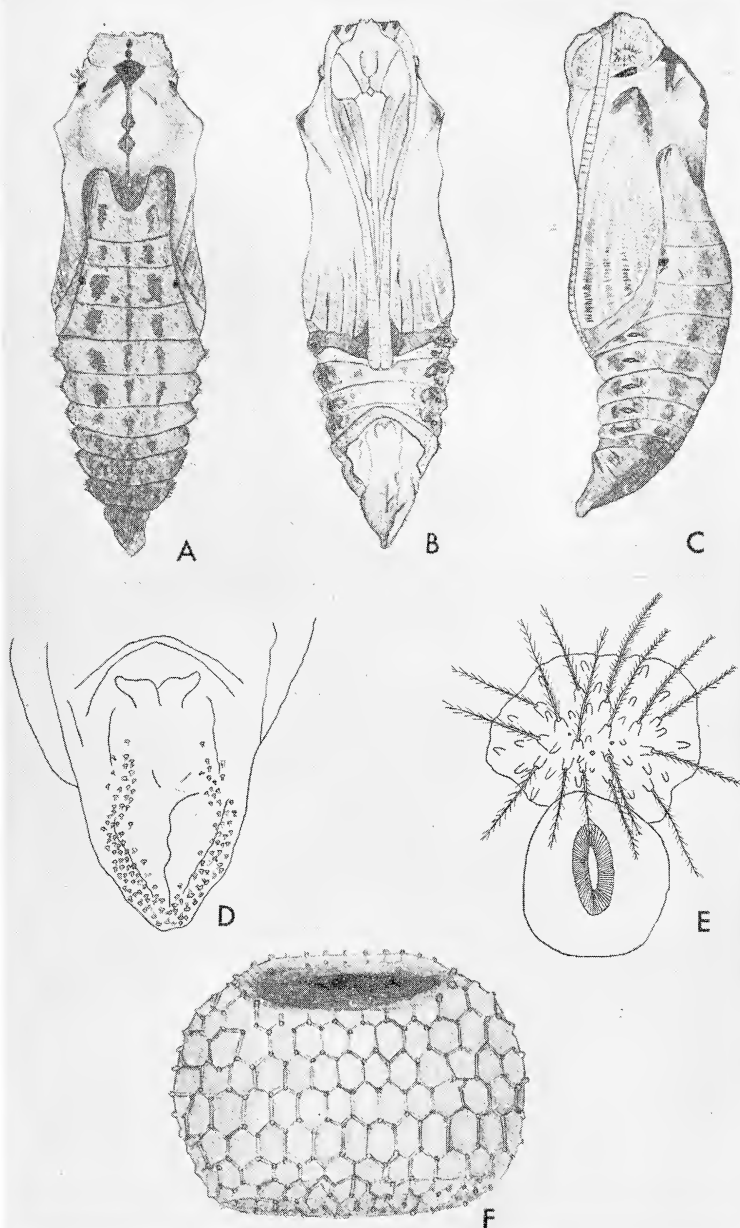


Fig. 3. A. Pupa, dorsal view (9X). B. Pupa, ventral view (9X). C. Pupa, lateral view (9X). D. Detail of cremaster of pupa (27X). E. Detail of pupal spiracle showing dorsal verruca (108X). F. Egg (75X).

Legs with claws now light brown. Prolegs concolorous with the ground color and with the crochets arranged in a triordinal mesoserries; ventral prolegs each with a protuberance as before separating the 38 mesal crochets from the 7 lateral crochets (fig. 4E); anal prolegs each with a similar protuberance but only a mesal mesoserries of approximately 50 crochets present (fig. 4I); prolegs each with approximately 4 setae and approximately 7 or 8 papillae arising from the planta.

Body ground color slightly darker than before; yellow shading at the segmental junctures now very evident. Dorsal part of the prothoracic segment slightly black. Middorsal longitudinal band now almost indistinguishable from the remainder of the body; "band" with markings (except the single, median, longitudinal stripes caused by the circulating blood on the third to the eighth abdominal segments) very faint and almost indiscernable. Supraspiracular row of black dots as before. Penultimate segment becoming totally dark green dorsally (except for a narrow paler margin) three days subsequent to the beginning of the stadium.

SIXTH INSTAR LARVA: Figs. 2B and C. (Measurements and duration are based on 4 specimens). Beginning of stadium-length, 15.0-16.3 mm.; width, 4.3-5.0 mm.; head diameter, 2.52-2.70 mm. Termination of stadium-length, 21.0-23.0 mm.; width, 5.0-6.1 mm. Duration, 26-29 days.

Head (fig. 2E) with the light border on the clypeus now light grey and more extensive than before; papillae more numerous than before and now on the entire head capsule.

Body shape less dorso-ventrally flattened than before. Eighth abdominal segment with the crescent-shaped ridges bordering the honey glands now more conspicuous. Spiracles more conspicuous than before.

The metathoracic lateral organs or tubercles consist of a finger-like invagination into the body wall. It appears as if these organs are of the basic lycaenid type described and illustrated by Ehrhardt (1914), Newcomer (1912), and Thomann (1901) in as much as they are invaginations of the cuticle and hypodermis. Figure 6B illustrates the structure of one of the organs. A thin cuticle (c) forms a lining to the retracted diverticulum, the opening of which in life, is covered with folds of the cuticle. The cuticle is modified at the basal one-fourth of the organ into approximately 12-14 trichose setae (s) that are completely concealed when the organ is in its contracted position; at the upper one-half of the organ into several "tactile papillae" (p) comparable to those scattered on the body surface; and at the lower one-half of the organ into numerous nipples (n). A single-celled layer of hypodermis (h) underlies the cuticle, the cells of which are small. These hypodermal cells under the papillae to which they are attached by thin, possibly neural, fibers, are large and pyriform. Numerous circular glandular structures (g) surround the lower-half of the organ beneath the hypodermis. The above mentioned nipples (n) are connected to these by means of fine ducts. A single retractor muscle (r. m.) inserts on the basal-most part of the organ and originates on the ventral body wall. Evagination of this organ is probably accomplished by an increase in the internal body pressure.

The "honey glands" consist of a complex of structures, several of which are different from those reported by Eltringham (1939), Erhardt (1914), Newcomer (1912), and Thomann (1901). Figure 6A illustrates the various structures and their relationships. A thin cuticle (c) forms a lining to the retracted eversible pouch (e. p.), the orifice of which is fringed by two crescent-shaped ridges bearing numerous papillae (p). The function of these papillae probably is to retain the "honey dew" and to keep it from flowing out and spreading over the surface of the body as is the case with the ant-attended aphids (Mordwilko, 1901). The orifice of this pouch in life is closed by folds of the pouch lining. A single-celled layer of hypodermis (h) underlies the cuticle, the cells of which are small. These hypodermal cells under the papillae to which they are attached by thin, possibly neural, fibers, are large and pyriform. A bladder (b) ventral to the eversible pouch that consists of a single layer of columnar epithelial cells. This may have the function of storing the "honey dew" which is probably manufactured in the gland (g) and transported to it through a small duct (d) composed of a single layer of cuboidal cells. A retractor muscle (r. m.) inserts at the base of the bladder and originates on the suprapedal lobe of the eighth abdominal segment. Evagination of the eversible pouch is probably accomplished by means of an increase in the internal body pressure.

Primary setae now very papillae-like and indistinguishable from the other body papillae. Secondary setae now very trichose (fig. 4P); the longest seta on the prothoracic horns approximately 1.4-1.6 mm. in length, all others being slightly shorter. Setal maps (fig. 5C) illustrate the arrangement of the setae.

Legs with claws now dark brown. Prolegs concolorous with the ground color and with the crochets arranged in a triordinal mesoserries; ventral prolegs each with a protuberance as before separating the 60-64 mesal crochets from the 7 lateral crochets (fig. 4F); anal prolegs each with a similar protuberance but only a mesal mesoserries of approximately 61-64 crochets present (fig. 4P); prolegs each with approximately 4 setae and approximately 7 or 8 papillae arising from the planta.

Body ground color slightly darker than before; the yellow shading at the segmental junctures is now more prominent and extensive. Dorsal area of the prothoracic segment now almost totally black. Middorsal, longitudinal band same color as before and indistinguishable except that it is bordered by irregular, longitudinal, brown markings forming a discontinuous subdorsal band; also, a discontinuous, ventral band of light brown markings present. Dorsal and lateral surfaces of cuticle with numerous small brown markings giving the body a mottled appearance. Supraspiracular

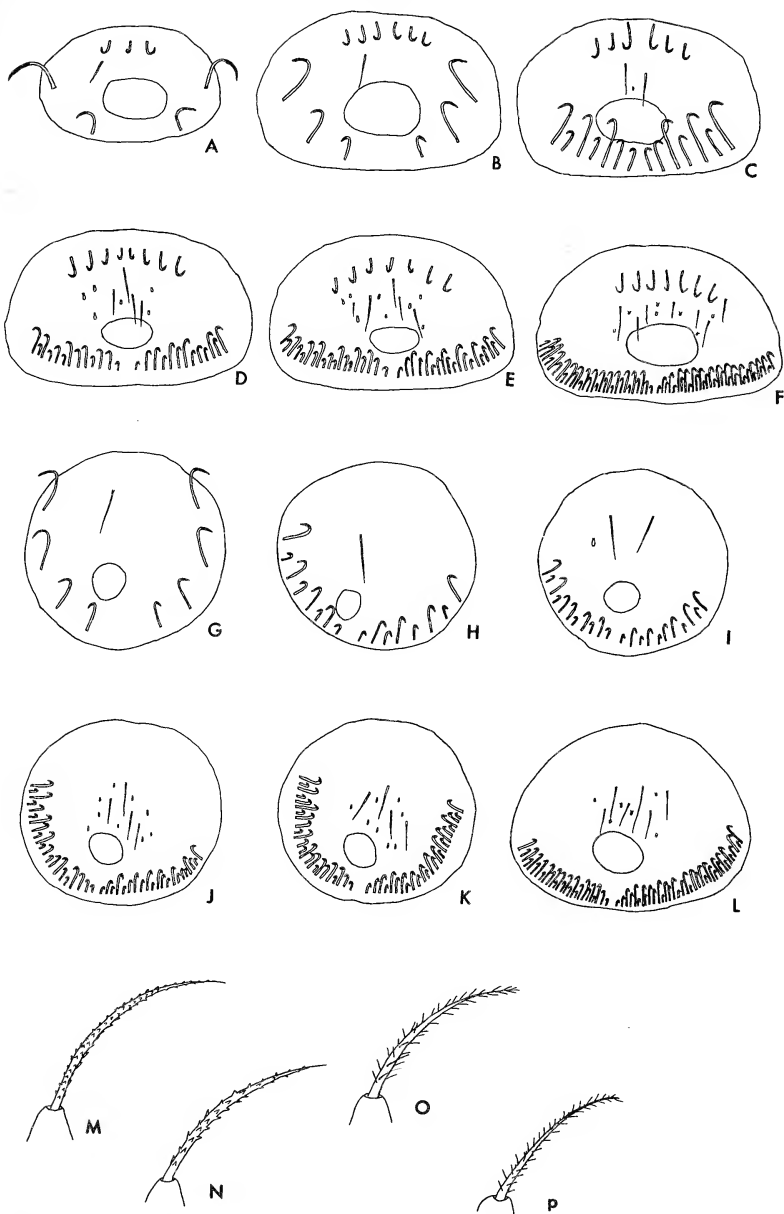


Fig. 4. A-F Ventral prolegs of larvae, measurements are approximate (A. First instar, 650X; B. Second instar, 260X; C. Third instar, 130X; D. Fourth instar, 55X; E. Fifth instar, 30X; F. Sixth instar, 25X). G-L Anal prolegs of larvae, measurements the same as those for the ventral prolegs (G. First instar; H. Second instar; I. Third instar; J. Fourth instar; K. Fifth instar; L. Sixth instar). M-P Setae of larvae (M. First instar, 30X; N. Third instar, 30X; O. Fifth instar, 22X; P. Sixth instar, 19X).

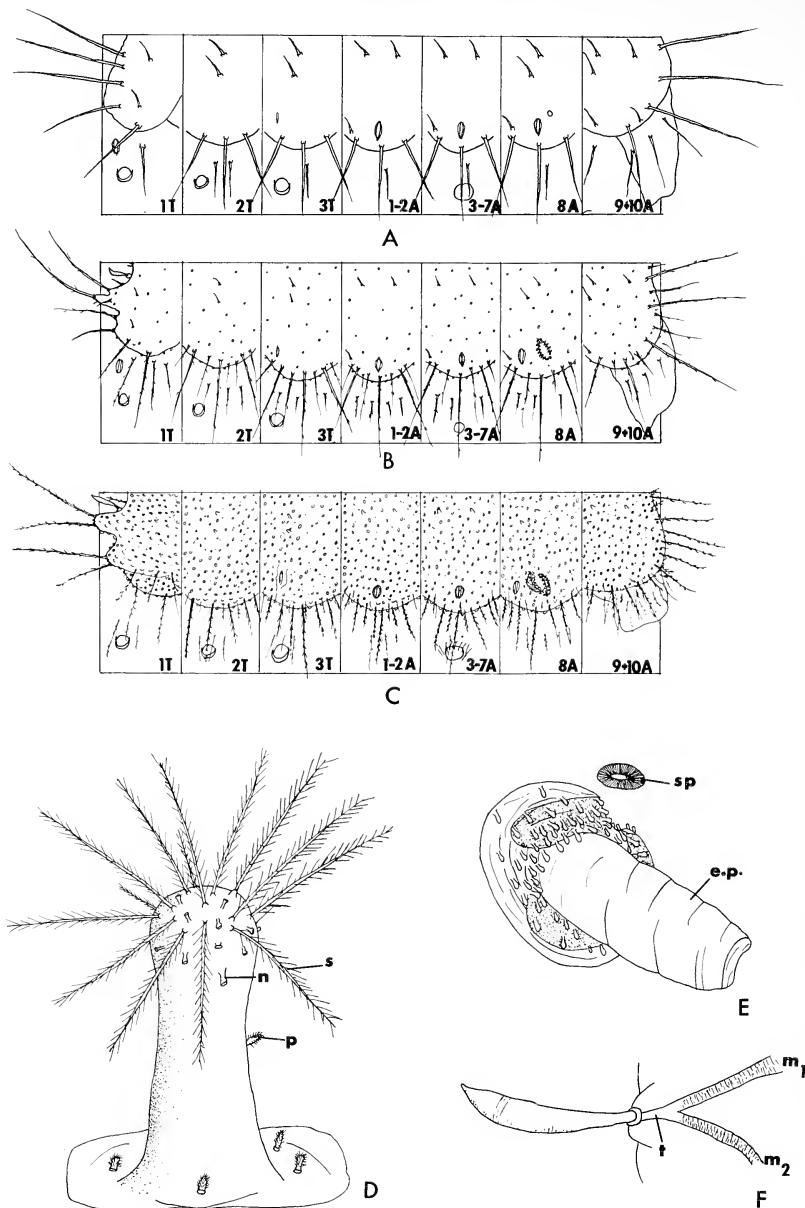


Fig. 5. A-C Setal maps of larvae (A. First instar; B. Third instar; C. sixth instar; T=thoracic segment, A=abdominal segment). D. Detail of everted lateral tubercle (53X); n=nipple, p=papilla, s=seta. E. Detail of everted "honey gland" (32X); e.p.=eversible pouch, sp=spiracle. F. Detail of "vibratory papilla" (58X); m₁=muscle originating on the posterior margin of the prothoracic segment, m₂=muscle originating on the post occipital ridge of the head capsule, t=tendon.

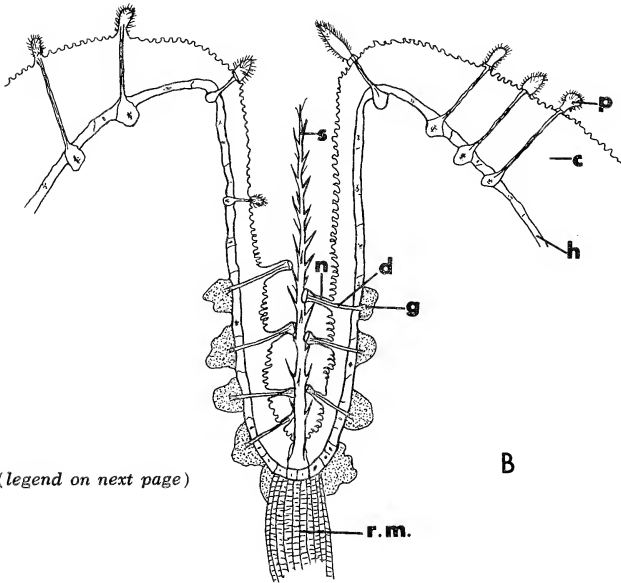
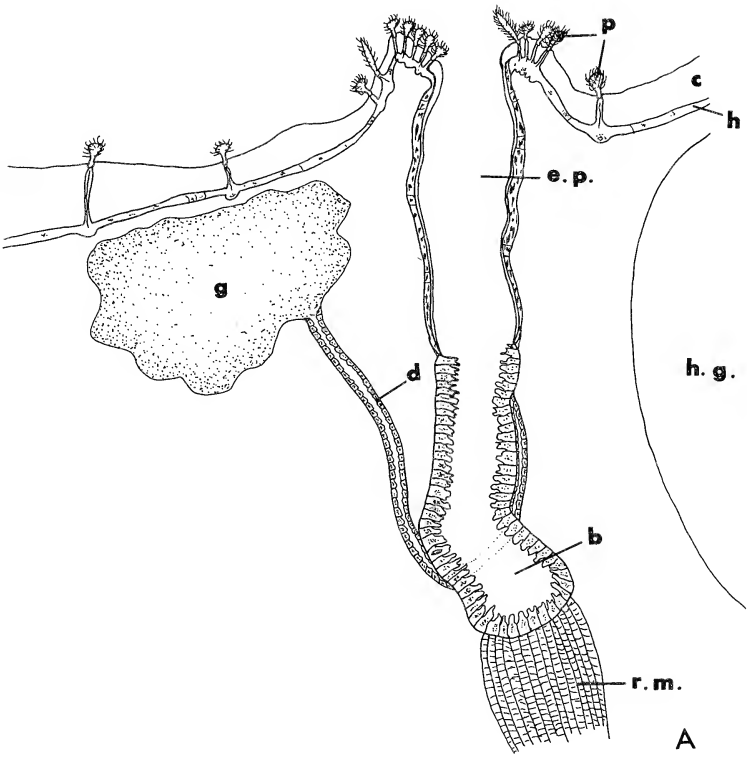


Fig. 6 (legend on next page)

row of dots as before. Papillae and granulations very abundant on all segments, predominately white but brownish on all brown cuticular markings. On the last two days of the stadium, the color fades to a pale yellowish green and practically all of the dark markings (except those on the horns and darkened area of the penultimate segment) disappear.

The secretory glands remain functional for the entire length of the stadium, even while the larva is hanging suspended from its support awaiting the period of pupation.

During the last two days of the stadium, the larva ceases feeding and remains constantly in its "pen." On the last day, the larva attaches the caudal segment, by means of silken threads, to the root or subterranean portion of the stem of the plant within the "pen."

It is interesting to note that the length of both the fifth and sixth instars appears to be exceedingly long (49-54 days total for both instars). Since these time durations are based on reared specimens in an artificial environment without ants, it is very possible that these stadia lengths may not be valid under natural conditions. Two facts lead me to conclude that my captivated larvae did not have a normal development: first, the observed head sizes of the sixth instar larvae are small as compared to the calculated head diameters (see table I); second, the food supply could hardly last the approximate 50 days for as stated under EGG, females oviposit on the rather small, "scrawny" plants. These plants did not possess enough foliage to support a caterpillar or two for that time duration. It may be that the tactile stimulation by the attending ants under natural conditions makes for a more rapid developmental period.

PUPA. Figs. 3A, B, C. (Measurements and duration are based on 12 specimens). Length, 14.0-16.3 mm.; maximum width, 4.8-5.9 mm. Duration, 11-13 days.

Head portion with eyes visible as brown blotches. Antennae extending slightly beyond wing margins. Proboscis slightly shorter than wing cases.

Thorax without any girdle. Metathoracic segment with a pair of glands in a position comparable to the lateral tubercles of the larva. Figure 7 illustrates one of the glands and the surrounding structures. A thin cuticle (c) with 3-5 nipples (n) overlies the gland (g). Each of these nipples has a small duct (d) leading from the nipple to the gland below. The gland lies in an exuvial space (e. s.) between the pupal cuticle and the newly-forming adult tissues, i. e., the cuticle (a. c.) and the basement membrane (b. m.).

Abdomen with a pair of scars in a position comparable to the pair of "honey glands" of the larva. Spiracles apparent; second through ninth pairs each with a small dorsal verruca bearing numerous small, trichose setae 0.1-0.2 mm. in length and numerous small papillae, some brown and some concolorous with the ground color (fig. 3E); also, a subspherical row of brown papillae and trichose setae. Abdominal segments terminating with the cremaster that appears as a ventrally flattened plate (fig. 3D). Dr. J. C. Downey (personal communication) informs me that the pupa has stridulatory organs between the fourth and fifth, and fifth and sixth abdominal tergites. These will be illustrated in one of my forthcoming papers.

Ground color light green (same color as that of the last instar larva) acquiring a slight yellowish tinge four days subsequent to the last larval molt and becoming dark brown two days prior to the adult's emergence. A narrow, discontinuous, middorsal, longitudinal, dark green band; also, numerous dark green-black blotches on the dorsal and lateral surfaces (the lower half of the abdomen is almost totally dark in color); very few markings ventrally except on the wing cases. Numerous tiny, light tan papillae (similar to those of the larva) covering all surfaces except the wing cases and the venter.

The above mentioned pupal glands are interesting in as much as this is the first time that any such glands have been observed. A couple of authors (Hinton, 1951; Roepke, 1918) state that several of the lycaenid pupae have what appear to be glandular openings on the seventh and/or eighth abdominal segments but in no case "has more than the presumed orifice of the resulting organ been described" (Hinton, 1951).

As stated earlier, pupation is in the "pen," the ants remaining in attendance for practically the entire duration of the pupal stage.

IMAGO: Adults are described and pictured by Clench (1964) in this same issue. The ecology and ethology of the butterflies will be discussed at a later date.

Fig. 6. A. Dorsal-ventral section through the region of a "honey gland" (53X); b=bladder, c=cuticle, d=duct, e.p.=eversible pouch, g=gland, h=hypodermis, h.g.=hind gut, p=papilla, r.m.=retractor muscle. B. Dorsal-ventral section through the region of a lateral tubercle (66X); c=cuticle, d=duct, g=gland, h=hypodermis, n=nipple, r.m.=retractor muscle.

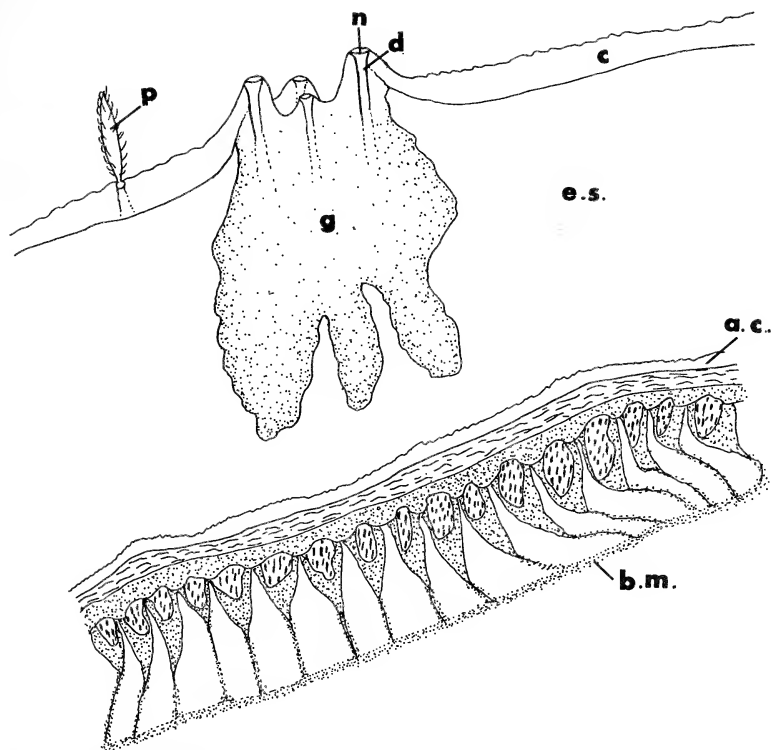


Fig. 7. Dorsal-ventral section through the region of a metathoracic, pupal gland (66X); a.c.=adult cuticle, b.m.=basement membrane, c=cuticle, d=duct, e.s.=exuvial space, g=gland, n=nipple, p=papilla.

TABLE 1

Observed and calculated head diameters based on Dyar's rule. Average figures were used in all calculations.

PERIOD (NO. OF INDIVIDUALS IN PARENTHESES)	OBSERVED HEAD DIAMETER (MM.)		PER CENT INCREASE	CALCULATED HEAD DIAMETER (MM.)
	RANGE	MEAN		
First Instar Larva (15)	.32- .33	.32	----	----
Second Instar Larva (13)	.52- .53	.52	1.63	.49
Third Instar Larva (12)	.77- .78	.77	1.48	.80
Fourth Instar Larva (9)	1.10-1.16	1.13	1.47	1.18
Fifth Instar Larva (8)	1.93-2.10	2.01	1.78	1.73
Sixth Instar Larva (4)	2.52-2.70	2.61	<u>1.30</u>	3.08
Average			1.53	

they extended to me during my stay in Ocotal Chico, and their children—Mike, Cindy, Laura, and Juanita, for their assistance with the field work and their companionship during my stay; Dr. V. E. Rudd (U. S. National Museum, Smithsonian Institution, Washington, D. C.) for plant determinations; Dr. M. R. Smith (U.S.D.A., A.R.S., U. S. National Museum, Washington, D. C.) and Dr. E. O. Wilson (Harvard University, Cambridge, Massachusetts) for ant determinations; Mr. and Mrs. H. R. Hermann (Louisiana State University, Departments of Entomology and Zoology, respectively) for histological preparations; Dr. J. H. Roberts (L.S.U., Dept. of Zoology) for photographic assistance; Dr. J. C. Downey (Southern Illinois University, Carbondale, Illinois) for informing me of the presence of pupal stridulatory organs; Mr. H. K. Clench (Carnegie Museum, Pittsburgh, Pennsylvania) and Mr. S. L. Warter, Dr. M. S. Blum, and D. L. D. Newsom (L.S.U., Dept. of Entomology) for criticisms and suggestions regarding the manuscript.

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REVIEW OF THE *DEPICTA* GROUP OF THE GENUS *ANNAPHILA*

WITH THE DESCRIPTION OF A NEW SPECIES FROM OREGON

JOHN S. BUCKETT AND W. R. BAUER

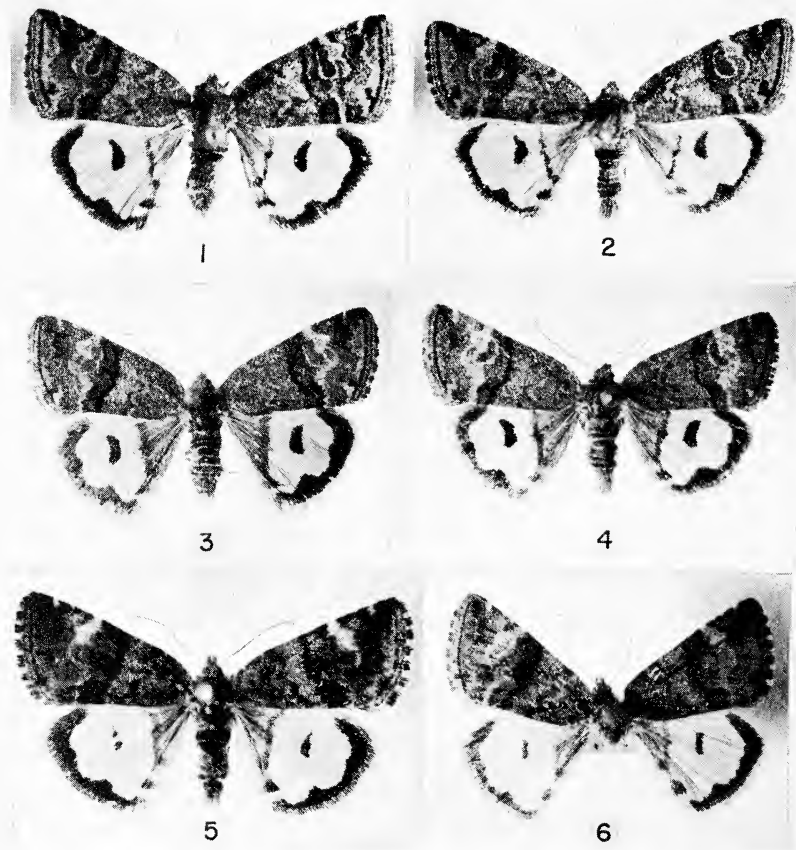
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THIS WORK HAS BEEN STIMULATED primarily by the discovery of a new species of *Annaphila* Grote (Noctuidae) from Oregon. Since Rindge and Smith (1952) have given thorough descriptions of *A. depicta depicta* Grote and *A. depicta morula* Rindge and Smith, we have only briefly evaluated these subspecies. *A. macfarlandi* Buckett and Bauer has been placed in the *depicta* group as a result of genitalic studies and wing maculation.

Thus far, the majority of *Annaphila* have been collected from and seem to be restricted to the Pacific Coast States, from southern California to British Columbia. One species, *A. pustulata* Henry Edwards, of the *mera* group, inhabits both Arizona and Texas and one specimen of *astrologa* Barnes and McDunnough was collected in Arizona.

Key to species of the *depicta* group

1. Ciliations on antennae in male less than $\frac{1}{2}$ length of each individual segment; primaries suffused with brown dorsally, no prominent brown median cross line or band; discal crescent of secondaries thin, not large (figs. 5 & 6) *macfarlandi*
- Ciliations on antennae in male more than $\frac{1}{2}$ the length of each individual segment; primaries suffused with gray dorsally; prominent median cross band of brown scales; discal crescent of secondaries large, thick 2
2. Ciliations on antennae in male nearly twice the length of each segment; dorsal surface of primaries lacking light brown area between reniform and transverse posterior line; secondaries with intradiscal line clearly defined on both sides by yellow orange ground color; outer marginal band thin, black (figs. 1 & 2) *depicta depicta*
- Ciliations on antennae of male equal to length of each individual segment; dorsal surface of primaries with light brown area between reniform and transverse posterior line; secondaries with basal area suffused with black to and including intradiscal line; discal crescent thick; outer marginal line thick, black (figs. 3 & 4) *depicta morula*



1. Adult female *Annaphila depicta depicta* Grote, Kelsey Creek, 3 miles west of Cobb, Lake County, California, March 30, 1961 (W. R. Bauer & J. S. Buckett.). 2. Adult male *A. depicta depicta*, same locality as figure 1, March 16, 1960 (W.R.B. & J.S.B.). 3. Topotype female *A. depicta morula* Rindge & Smith, La Tuna Canyon, Los Angeles County, California, March 11, 1948 (C. Hennie). 4. Topotype male, *A. depicta morula*, same locality as figure 3, February 22, 1947 (W. H. Evans). 5. Holotype female *A. macfarlandi* Buckett & Bauer, 5 miles northwest Corvallis, Benton County, Oregon, April 11, 1962 (A. N. McFarland). 6. Allotype male *A. macfarlandi* Buckett & Bauer, Corvallis, Benton County, Oregon, March 20, 1937 (S. Jewett, Jr.).

A. depicta depicta Grote

Annaphila depicta Grote, 1873. Bull. Buffalo Soc. Nat. Sci. 1:150, pl. 4, fig. 13. Type female, San Mateo County, California (Bri. Mus.).

Male: Head clothed in gray and black scales and hairs; front protruding, truncate; antennae ciliate ventrally, ciliations longer than each individual segment; dorsally with black scales, distal portion of segments white. Primaries of gray ground color, basal line wanting; transverse anterior line geminate, black to brown; median line thin, black, outwardly shaded with wide brown band; orbicular wanting; reniform gray, outlined with white scales; transverse posterior line separate by white scales, strongly incurved below reniform, thence straight to inner margin; subterminal line zig-zagging, becoming broader near inner margin; apex of primaries suffused with black scales; terminal line black. Ventral surface of primaries with ground color yellow-orange, median line, reniform, and subterminal line present, black. Secondaries dorsally yellow-orange; basal area suffused with black scales; intradiscal line black; discal dot large, black, crescent shaped; patch of black scales midway between inner angle and intradiscal line; outer marginal band black, thin. Ventral surface of secondaries paler yellow-orange. Abdomen black, terminally with brown hairs. Male genitalia as in figs. 7 & 8.

Female: As in male except antennae possess shorter ciliations. Female genitalia as in fig. 13.

This subspecies is the most abundant *Annaphila* in central and, perhaps, northern California. It can be recognized by its gray primaries which are distinctly brown banded medially. In the past few years one was able to see thousands of *depicta depicta* on the wing in a single day in mid March. Like other members of the genus, *depicta depicta* is found about wooded streams and other moist areas, and occasionally in drier areas.

Annaphila depicta murula Rindge and Smith

Annaphila depicta morula Rindge and Smith, 1952. Bull. Am. Mus. Nat. Hist. 98(3):232, fig. 4C. Type male, La Tuna Canyon, Los Angeles County, California (Amer. Mus. Nat. Hist.).

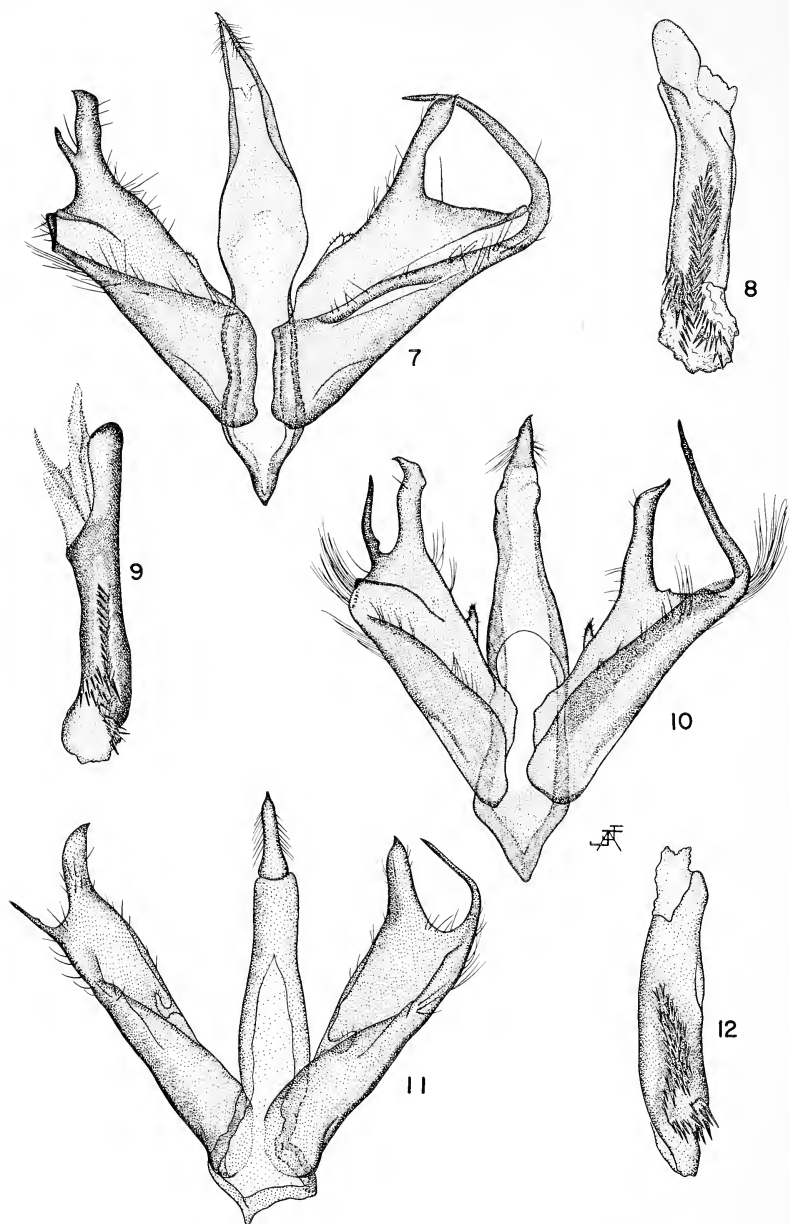
Male: Head as in preceding subspecies except shorter ciliations on antennae. Dorsal surface of primaries more gray-brown, reniform outlined in light brown scales; area between reniform and transverse posterior line of light brown scales, diminishing in width near inner margin. Ventral surface of primaries as in preceding subspecies except greater suffusion of black scales in yellow ground color, thereby giving a duller appearance. Secondaries with dorsal surface more dull yellow-orange than in *depicta depicta*; basal area more suffused with black; discal crescent larger; outer marginal band broader; ventral surface of secondaries slightly suffused with black scales, thereby appearing duller than nominate *depicta*. Abdomen as in *depicta depicta*. Male genitalia as in figs. 9 & 10.

Female: As in male except antennae possess shorter ciliations. Female genitalia as in fig. 14.

Larva: For notes on and description of larva, see Rindge and Smith (1952).

Location of type: American Museum of Natural History, Male.

Type locality: La Tuna Canyon, Los Angeles County, California.

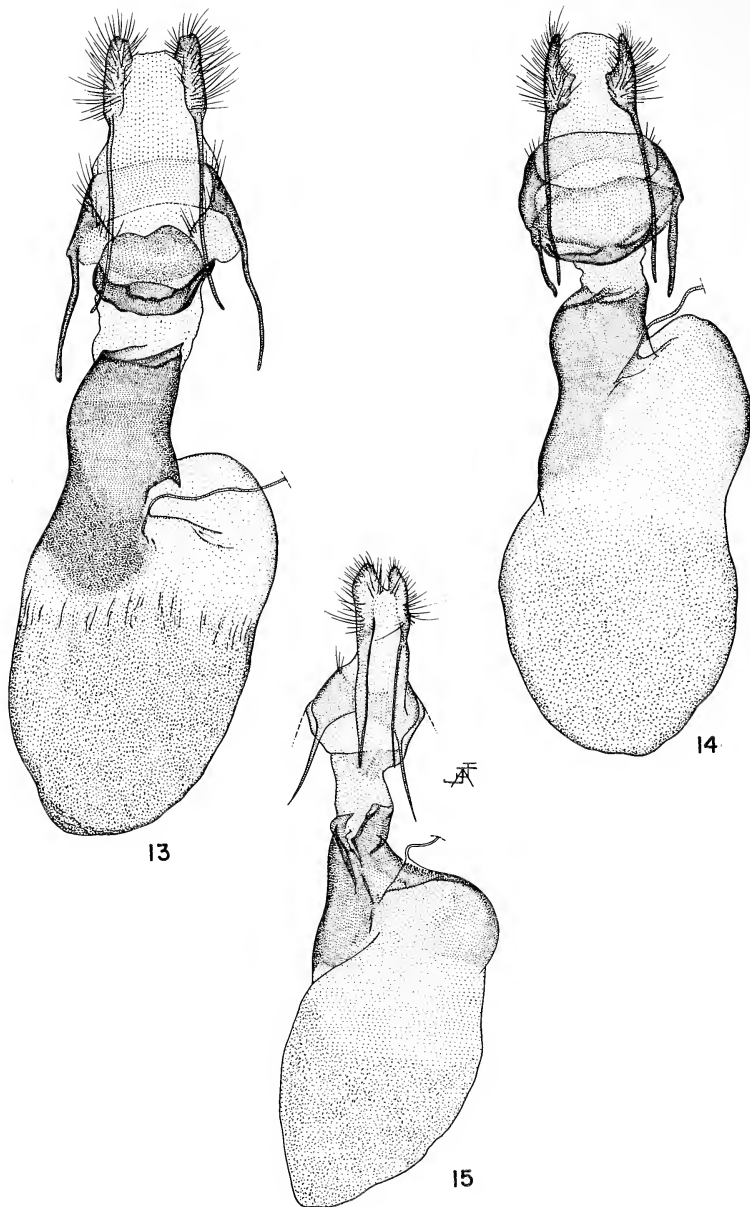


7. Male genitalia minus aedeagus, *A. depicta depicta* (Bauer-Buckett Slide No. 63B13-1), Kelsey Creek, 3 miles west of Cobb, Lake County, California, March 16, 1960. (W.R.B. & J.S.B.). 8. Aedeagus, *A. depicta depicta*, same data as figure 7. 9. Aedeagus, *A. depicta morula* (Bauer-Buckett slide No. 63G20-23), same data as figure 3. 10. Male genitalia minus aedeagus, *A. depicta morula*, same data as figure 3. 11. Allotype, male genitalia minus aedeagus, *A. macfarlandi* (Bauer-Buckett Slide No. 63B14-2), same data as figure 6. 12. Allotype, *A. macfarlandi*, aedeagus, data same as figure 6.

A. depicta morula is collected in February and March along creeks and on dry hillsides. The distinguishing characteristics of this subspecies are: (1) Lighter area between reniform and transverse posterior line of primaries; (2) More suffused basal area in dorsal surface of secondaries; (3) Broader outer marginal band of secondaries; (4) Suffusion of ventral surface of wings with black scales thus giving them a duller appearance than nominate *depicta*.

Annaphila macfarlandi Buckett and Bauer, new species

Holotype female: Head with vertex and front clothed with an admixture of brown and white hairs; front projecting, truncate; palps with extremely long brown and white hairs; head ventrally clothed in pure white hairs; proboscis brown; antennae simple, ventrally ciliate, dorsally black with distal portions of segments white, becoming uniformly black-brown terminally. Thorax dorsally dark brownish black, dorso-laterally clothed with a mixture of white tipped brown spatulate scales and yellowish simple hairs; ventral surface clothed in pure white to yellowish white hairs. Legs with femoral and tibial segments clothed in a mixture of white and brown hairs, tarsal segments dorsally black with apical portion of each segment thinly banded with white scales, ventrally clothed in white scales. Primaries dorsally with basal area grayish; basal line slightly convex medially, black; transverse anterior line undulating from costa to inner margin, becoming very strongly black on anal veins where it forms a distinct concave "V", shaded outwardly with gray; median cross line distinct, black, slightly concave from costa to inner margin where it forms a black dot with two apical black teeth on anal veins; orbicular and claviform absent; reniform very obscure with outer edge on transverse posterior line; transverse posterior line costally a broad whitish wedge extending to and including base of reniform, thence overlain with golden-brown scales becoming hardly discernible; subterminal space overlain with golden-brown scales from inner margin to a point opposite top of reniform where there is a distinct black convex "U" adjoining sub-terminal line; directly above this "U", there is a small white wedge on costal margin with a black area from there to terminal line; subterminal line represented by small black shadings on veins; terminal space gray; terminal line represented by black lunules between veins; fringed with a checkerboard pattern of black and white. Ventral surface of primaries with ground color orange yellow from base to beyond reniform; a distinct black medial band is present being broad at costa, outcurving below reniform and diminishing to a thin line on inner margin; reniform present in black; subterminal space black, extending black rays along veins into terminal area. Subterminal line light yellowish white; fringes black and white checkered. Greatest length of forewing 12 mm. Secondaries dorsally with basal area suffused with black scales and overlain with pale orange hairs; intradiscal line black, broad, more or less straight; patch of black scales extending from inner margin between intradiscal line and anal angle; discal dot a prominent black wedge with point directed toward anal angle of forewing, outer margin with broad black band becoming broader on Cu_2 and at anal angle; fringes dull orange to light brown. Ventral surface of secondaries with same orange yellow ground color of primaries; basal area lightly suffused with black scales; intradiscal line black, thin, incomplete medially, then turning sharply to inner margin $\frac{1}{2}$ the distance between the base and hind angle; black discal dot prominent; post median line thin, discontinuous, very erratic in its course, somewhat paralleling terminal line; terminal line black, broadest at apex and at cubital area; fringes dull orange.



13. Female genitalia, *A. depicta depicta* (Bauer-Buckett Slide No. 63G20-21), same data as figure 7. 14. Female genitalia, *A. depicta morula* (Bauer-Buckett Slide No. 63G20-22), same data as figure 3. 15. Paratype female genitalia, *A. macfarlandi* (Bauer-Buckett Slide No. 63B14-1), Forest Grove, Oregon, April 28, 1935 (S. Jewett, Jr.).

Abdomen with dorsal crest basally; segments dorsally black with apical margin of yellowish scales, laterally with long dull yellow hairs. Ventral surface of abdomen with dull yellowish hairs. Genitalia as in fig. 15.

Allotype male: As in female, except ciliations longer on antennae, ventral hairs of head and thorax not as pure white; ground color of primaries golden brown, therefore maculation not as contrasting as holotype female. Greatest length of forewing 10 mm. Genitalia as in figs. 11 & 12.

Holotype female: McDonald Fork of Oak Creek, 5 miles northwest Corvallis, Benton County, Oregon, elevation 500 feet, April 11, 1962 (A. Noel McFarland).

Paratypes (all from Oregon): One male (designated Allotype) Corvallis, March 20, 1937 (S. Jewett, Jr.) (Bauer-Buckett Slide No. 63B14-2); One male Corvallis, March 20, 1937 (S. Jewett, Jr.); One male Kane Creek, March 18, 1934 (B. and B. Slide No. 63B13-2); One female Forest Grove, April 28, 1935 (S. Jewett, Jr.) (B. and B. Slide No. 63B14-1); Two females, Forest Grove, April 28, 1935 (S. Jewett, Jr.).

The holotype is deposited in the Entomology collection, University of California, Davis, California. The male allotype, two female paratypes, and one male paratype are deposited in the Bauer-Buckett collection, Davis, California. One female paratype is deposited in the collection of Noel McFarland, Valyermo, California, and one female paratype in the American Museum of Natural History, New York.

This species is most closely allied to *A. depicta* Grote. Superficially, it can be easily distinguished from *depicta* by its browner coloration, presence of a white wedge on costa of the primaries, and the pure white vestiture on the vertex of the head. *A. macfardandi* has a more northerly distribution, thus far known only from Oregon.

The species is named for Anthony Noel McFarland who collected the holotype specimen and made the type series available.

LITERATURE CITED

- RINDGE, F. H. and C. I. SMITH, 1952. A revision of the genus *Annaphila* Grote (Lepidoptera: Phalaenidae). *Bull. Amer. Mus. Nat. Hist.* 98(3): 191-248 plus 8 plates.

NOTICE

AN APOLOGY:

First, for the lateness of this issue of the JOURNAL. An extensive trip in the summer has put the editor behind in many commitments, including seeing this Journal through the press. Needless to say, we expect to be right up there on schedule by the first of the year.

Second, for the lack of four-color illustrations in this number. This is not intentional but, in fact, is correlated with the problem explained above.

We wish the JOURNAL to reach as broad an audience as possible, and sincerely request the submission of manuscripts from all over the world. Even articles not specifically mentioning LEPIDOPTERA, but of general biological nature, such as population analyses, zoogeographical principles, etc. are welcome. We favor well illustrated articles and can make full color illustrations at very low cost to the author. -----the editor.

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BIONOMICS OF AGATHYMUS (MEGATHYMIDAE)

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OBSERVATIONS OF ALL THE NAMED AGATHYMUS forms occurring in the United States have convinced me that their bionomics are, in many respects, similar enough to be presented in a general account. Unless otherwise noted the observations on which this study was based refer to the following Arizona forms: *Agathymus neumoegeni* (Edwards), *A. polingi* (Skinner), *A. evansi* (Freeman), *A. aryxna* (Dyar), *A. baueri* (Stallings and Turner), *A. freemani* S. and T., and *A. alliae* (S. and T.).

Variations in bionomics at the species level will be treated in a paper currently being prepared.

ADULTS

The species of *Agathymus* are limited to tropical and subtropical America by the distribution of their food plants, members of *Agave*. The northern distributional limits of the *Agathymus* species lie in southern California, southern Nevada, southern Utah, and central New Mexico. It is expected that these limits will remain fixed because the northern limits of *Agave* are encompassed by this area. The known southern limit presently lies in Panama, but I expect the *Agathymus* are represented in northern South America where agaves are known to occur. Sixteen named forms are known from the United States with Texas and Arizona containing the greatest number, eight and seven respectively.

The adults, which are diurnal, fly during the late summer and fall months. Their flight is usually very swift and erratic. Numerous feeding observations indicated that only the males feed. Feeding always took place on a damp substrate, i.e., wet sand, mud, fresh manure, or directly from water. I have no evidence that these insects visit nectar sources. An apparent preference was shown for feeding sites located in the shade.

¹ This study was conducted as a partial fulfillment of the requirements for the Master of Science Degree at the University of Arizona.

Continuous feeding was noted for periods up to thirty minutes. In cases where individuals remained at a feeding site for several hours the feeding was discontinuous. While feeding the males continually excreted drops of liquid. The assimilation and excretion of liquid in large amounts suggests that some material in a weak solution may be removed by the insects. It does not seem reasonable that lengthy feeding would be necessary to replace water lost in metabolism. All of the Arizona forms except *A. alliae* and *A. polingi* were taken at water. The former can not be considered a nonfeeder because a suitable substrate was not present where that species was observed. *Agathymus polingi* showed no indication of feeding, even when nearby water sources were attracting *A. aryxna*.

Observations of adults made in colonies of their respective foodplants indicated a given population may be divided in the morning hours as follows: virgin females, gravid females, territorial males, and transient males. Females which were apparently virgin were rarely encountered in the field, but these limited observations indicated that mating took place soon after eclosion if males were available.

The mating procedure of members of the *A. polingi* complex was observed four times and of *A. baueri* once under natural conditions. Based on those matings, plus observations when caged virgin females were released in the wild, the following account of an *A. polingi* mating is regarded as typical. A female was seen flying over a dense patch of the foodplant about two feet off the ground when a male, perched roughly six feet from her line of flight, suddenly gave pursuit. The male was approximately six inches away when the female alighted abruptly, followed closely by the male which landed parallel to her and about one-half inch away. The female half-spread her wings and fluttered them rapidly while the male remained passive with wings held tightly together. After several seconds passed the male curved his abdomen laterally so that his genitalia touched the caudal tip of the female. This behavior was repeated three or four times before the female responded by depressing the central part of her abdomen and exposing her genitalia. The male attached himself immediately, then walked slowly away from the female in an arc of 180° . After slight movements on the female's part the pair came to rest so that the two faced in opposite directions. The estimated time required for courtship and engagement was one minute. Copulation in the field was

noted between 10 and 11 A.M., whereas the copulation of caged specimens generally took place between 8 and 10 A.M., with the matings lasting three to four hours.

Males of all forms, except *A. evansi*, exhibited territorial behavior. Observations of *A. evansi* were limited to transient males and ovipositing females. Territories were all proximate to the foodplant with perches being established on rock outcroppings or on dead and living portions of the foodplant. Territories were obvious from 8:30 A.M. to 1 P.M. During this period the males frequently sat with the forewings opened to approximately 75° and the hindwings held at about 45° , oriented in such a position that the upper wing surface was directly exposed to the sun. Territorial males showed a keen sense of recognition for virgin females and transient males, but rarely left their perches to investigate ovipositing females, *Agathymus* of other species, or other insects passing through their territory. Territory infringement by transient males invariably resulted in pursuit by the territorial male. This pursuit resulted either in both participants leaving the territory in a low-level, linear flight or in a "dogfight" with the participants rising vertically to varying heights. In the case of the low-level flight the male usually returned to the original perch, or one close to it, within a minute. If there was a "dogfight" flight, frequently three or four minutes passed before a male returned to occupy the territory. Based on the rare cases where a wing defect permitted recognition of a territorial male, it appeared that the original occupant returned to his territory after an encounter with a transient.

In the few cases where males left their perches to investigate ovipositing females they returned to the perches after approach no closer than two or three feet. With virgin females the males, without hesitation, approached much closer, resulting either in mating within the territory, or a low-level flight into adjoining territories with other males joining the original pair. Under the competitive conditions of the latter case no matings were observed.

In an attempt to determine how the males differentiate between virgin and gravid females, caged females (of *A. baueri* and *A. polingi*) in both conditions were placed near territorial males. These males showed no sign of recognition until the females were released, after which the responses noted previously under natural conditions were duplicated. A theory which

appears to be supported by my observations is that recognition is bidirectional in that while the initial recognition response is made by the male, the receptive female furthers this response by emitting a pheromone when the male approaches.

During the afternoon hours territorial behavior is abandoned, perhaps because the females which emerged that day have mated. The males at that time of day can be classified as transient or sedentary. The sedentary males usually sat in the shade with their wings closed and ignored the transients. In the afternoon the transient males seemed to be those individuals going to and from water or searching for a resting place. I believe many males which occupy fixed territories in the morning become transitory in the afternoon. This belief is founded on the observation that in the afternoon males were often absent from areas they had occupied in the morning. It was not possible for me to recognize the same male in any given territory two days in succession.

Throughout the morning transient males appeared to be those going to or from a food source or males searching for a territory. I saw no indication that these males were seeking females. During peak flight periods several observations such as the following were made:

After observing, for one hour, the behavior of two males of *A. baueri* which had established territories in a small clearing, they were collected. In the next two hours thirty-four males were taken as they established territories in the clearing. The majority chose the same perches from which the first two males were collected.

That some transients are searching for territories and that a territory selected by one male fits the requirements of many males seems obvious after such observations.

Oviposition by *A. aryxna*, *A. baueri*, *A. freemani*, *A. evansi*, *A. polingi*, and *A. neumoegeni* was observed under natural conditions, the method being similar for each. Foodplant selection was usually rapid. Females seldom were seen fluttering around a group of plants in an apparent effort to locate a particular site for oviposition. The substratum on which oviposition took place was generally the under surface of a leaf near the tip in the central third of the plant. Tactal contact with the foodplant was not necessary to stimulate oviposition because some females laid eggs while sitting on rocks and branches lying near agaves. Upon alighting the female would remain stationary for a brief period, then curve her abdomen until the tip came in contact with the substratum, after which the abdomen was returned to

its normal position. These movements were made slowly, without a flicking or lateral movement of the abdomen. As the tip was removed from the substratum an abdominal contraction was visible, which resulted in the expulsion of a single egg. The egg, which lacks an adhesive, would then fall to the leaf base or onto the ground. The females always took flight after laying each egg, although they would occasionally return to the same plant several times for oviposition. The final resting place of the egg, if laid when the female is on a plant, is in part determined by the leaf arrangement. The eggs lodge between the leaf bases of those *Agave* with a compact leaf rosette, but usually fall to the ground if the plant has an open leaf arrangement. In the field oviposition was noted between 11 A.M. and 3 P.M. The only previous observation of oviposition under natural conditions differs markedly from mine. Freeman (1951), reporting on *A. aryxna* and *A. evansi* stated, "The method of egg laying was to flick the abdomen from side to side as they flew around the agave plants. The female attempted to flip the egg into the plant; the larvae then would not have to crawl far to arrive at food."

The number of eggs produced and the period over which they are laid can only be surmised from laboratory results. Caged females laid from 80 to 152 eggs, with no clearly defined differences between species. During the first twelve hours after mating the females laid at least half of their eggs. There was a noticeable drop in the eggs produced during the following 48 to 72 hours, but roughly twelve hours prior to death the oviposition rate increased sharply. Death occurred from four to five days after mating. An example which I consider typical, based on *A. neumoegei*, is as follows: 2-12 hours after mating, 70 eggs; 12-83 hours after mating, 18 eggs; 83-100 hours after mating, 25 eggs. The female then died and dissection revealed twelve fully formed eggs still present in her abdomen. Captive females oviposited over a much longer period each day than did females under natural conditions.

The adults are strongly solar positive in that flight activity stops shortly after clouds block the direct sunshine. During such periods the adults sit quietly with wings closed.

No observations were made which would indicate the nocturnal resting sites. On two occasions I spent several hours at night in a locality where *A. polingi* and *A. aryxna* were common, but failed to locate the sleeping insects. Brown and

Creelman (1935), reporting on the habits of *Agathymus stephensi* (Skinner) in San Diego County, California, stated that males were found sleeping on the outer branches of bushes at varying heights, but not on the foodplant. It is puzzling that they could only locate the males.

The longevity of adults under natural conditions is not known, but obviously is encompassed by the flight period in a given locality. The observed flight periods range from five to twelve weeks, depending on both the species and population. Caged specimens (males and unmated females) exposed to direct sunlight without access to water survived for as long as ten days, with four to seven days appearing more normal under those conditions. Both males and females survived for two to three weeks under refrigeration at 20 C.

OVA

The eggs of all species are hemispherical with a slightly concave base (Fig. 1). The chorion has a finely granular texture except for the micropylar area which appears smooth. Both external and internal color changes are visible during incubation. A composite account of these color changes, based on the Arizona species, is as follows: The egg at the time of oviposition was a shade of green or yellow, depending on the species. Shortly after being laid a marking in some shade of red developed on the chorion. Within a day after being deposited most eggs were plainly marbled over all parts of the shell. Each egg appeared to have a different pattern. The ground color and marbling became darker with age, maximum color intensity being reached in about six days. By the ninth day the shell began to lose color and internal color changes were visible, particularly the dark head capsule of the developing larva. By the twelfth day all external coloration had disappeared and the color of the larva was visible through the chorion.

Embryological development was completed from nine to twelve days after oviposition, judging from larval characters visible through the shell. Eclosion occurred from twenty-two to fifty-two days after oviposition in all eggs subject to outside temperatures and humidity changes. Eclosion from some ova kept at room temperature occurred from eighteen to twenty-four days after being deposited. Several five-day old eggs of *A. polingi* were refrigerated at 2°C. for three days. Larvae emerged from these eggs four to five days later than larvae from nonrefrigerated eggs laid at the same time. This indicates that

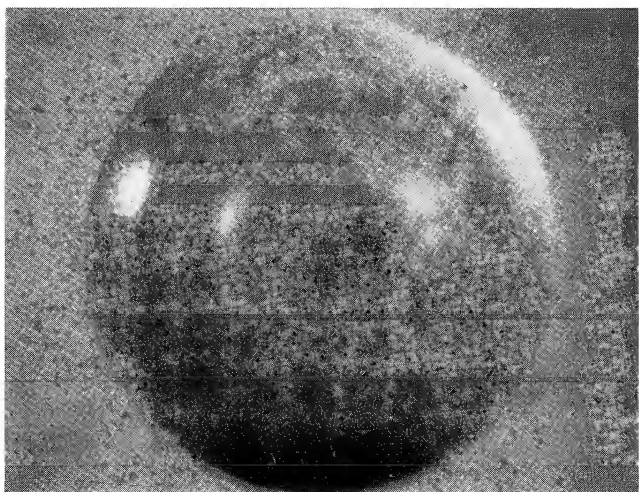


Fig. 1. Dorsal view of *Agathymus baueri* egg.

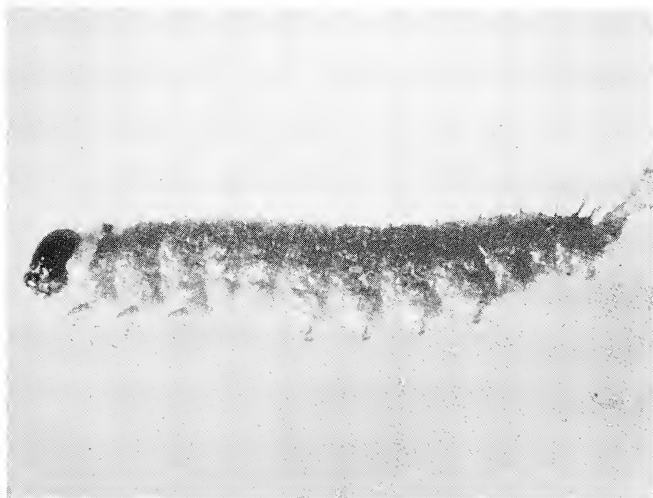


Fig. 2. First instar larva of *Agathymus polingi*.

temperature may play an important part in the time of eclosion under natural conditions. At least some larvae of all the Arizona species of *Agathymus* are known to emerge from the egg during late autumn.

The eclosion process required from one to three days. The first indication that eclosion was about to occur was the appearance of a minute hole in the micropylar area. This hole was slowly enlarged by the larva until the entire micropylar area, as well as part of the surrounding chorion had been consumed, leaving a jagged opening slightly larger than the head capsule. When the hole had reached a size sufficient to permit emergence the larva left the shell within a few minutes. Some lepidopterous larvae are known to consume the entire egg shell after eclosion. *Agathymus* larvae showed no interest in feeding on the chorion after hatching, even under starvation conditions.

LARVAE (Fig. 2)

After eclosion the larvae crawled toward the leaf tips. While they crawled they applied a continuous layer of silk to the leaf surface, apparently to gain a better foothold. Larvae which were transferred to a new leaf surface did not maintain their position unless given an opportunity to construct a silk holdfast.

The larvae did not attempt to feed until they reached the apical half, or more frequently the apical third, of the leaf. Feeding commenced with the excavation in the epidermis of a circular hole which slightly exceeded the larva in diameter. These excavations were most frequently made on the upper surface of the leaf and typically were directed toward the leaf tip. Usually within two days the larvae had burrowed to a depth which concealed them from view. One to five weeks were required to complete the apical gallery. (Fig. 3) The variation in time taken to construct the tunnel resulted, at least in part, from temperature effects on larval activity, the temperature during October and November being quite variable. During tunnel construction the larvae spun a fine silk webbing over those parts of the tunnel wall not involved with the excavation in progress. Despite the silk, sap at times entered the galleries in sufficient quantity to trap the larvae or force them to abandon the burrow. "Sapping out" occurred during periods of warm weather throughout the winter, probably due to sudden increases in sap flow which ruptured the silken tunnel lining. This was frequently noted at lower elevations in southern

Arizona where the temperatures were seldom low enough to result in a continuous state of arrested plant growth. Larvae that were "sapped out" immediately began to construct new tunnels on the same leaf or an adjoining one. Up to eight tunneling attempts resulted before some larvae became established in a dry burrow. Occasionally dead larvae were found clinging to the leaves, likely victims of the weather. First, second, and early third instar larvae were present during the winter in populations where "sapping out" was frequent. Larval growth during the winter seemed to be proportional to the number of galleries a larva was forced to make. At higher elevations the period of arrested plant growth was continuous and "sap outs" were rare. There the larvae over-wintered in the first instar.

All larvae resumed feeding with the advent of warmer temperatures in the spring. Growth was rapid as first, second, or early third instar larvae either enlarged the apical galleries where they had over-wintered, or made new ones, generally directed toward the leaf tip. During the third instar the larvae left the apical galleries and crawled to the base of the leaves where another tunnel was made. The basal tunnel was always located in the lower quarter of the leaf and directed downward toward the caudex. The choice of the upper or lower leaf surface for the entrance to the basal tunnel depends on the species of *Agathymus*. The remaining stadia were passed in the basal tunnel. "Sapping out" often resulted when basal galleries were being established. Larvae that were "sapped out" of basal galleries usually failed to establish new galleries, a high mortality thereby resulting in some populations.

As soon as a larva was concealed in the base of a leaf it proceeded to enlarge the gallery to several times its own width. Although the gallery was constantly being enlarged during the remainder of the third, throughout the fourth, and early in the fifth instar, the entrance remained small, being kept only large enough to facilitate defecation. The viscid, dark brown frass expelled from the basal galleries contrasted sharply with the relatively dry, light green frass often produced when feeding occurred in the apical galleries. The viscid frass accumulated around the entrance, where it hardened, possibly offering the larva some protection from natural enemies. For a number of years it was thought that some *Agathymus* species did not deposit frass outside the burrow entrance. It is now known that all the species occurring in the United States deposit a large

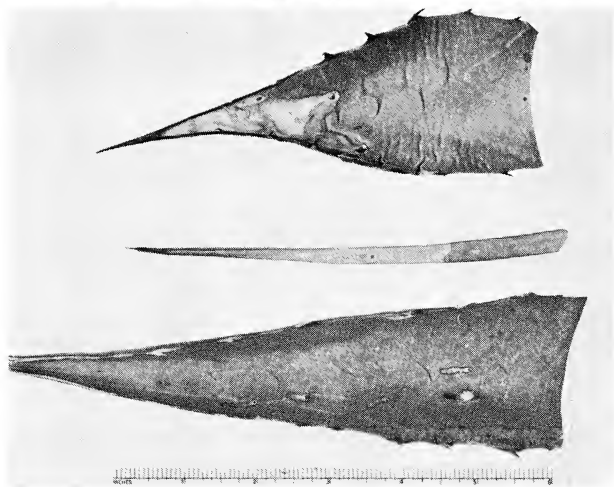


Fig. 3. A leaf of *Agave parryi* showing the apical gallery, trapdoor, and basal tunnel made by *Agathymus neuromoeni*.

Fig. 4. Looking into a large plant of *Agave parryi* containing four trapdoors made by *Agathymus neuromoeni* larvae. The adults have emerged from three of the burrows. Note the frass accumulation beneath the trapdoors.

Fig. 5. Apical galleries made by 1st and 2nd instar *Agathymus* larvae. Top: *A. neuromoeni* in *Agave parryi*. Middle: *A. polingi* in *Agave schottii*. Bottom: *A. aryxna* in *Agave palmeri*.

quantity of frass outside the burrow which is usually dispersed by summer rains before pupation occurs.

Prior to moulting the larvae sealed the entrance with silk, which was removed when feeding was resumed three or four days later. Through the first four instars and part of the fifth the larvae were primarily pulp feeders, but during the latter part of the fifth instar the larvae appeared to be exclusively sap feeders. The tunnel reached maximum size shortly after the onset of the fifth instar, but the lowest portion of the burrow was kept free of silk and sap entered freely. Sap feeding was suggested because the larvae were often seen with their mouth-parts in proximity to the sap accumulation at the base, but actual feeding was not observed. Feeding in the basal gallery may last from one to three months, varying both within and between species. The physiological condition of the plant, particularly sap flow, is believed to play an important part in the rate of larval development.

The division of feeding between the young larvae in the apical galleries and the older larvae in basal tunnels is not understood, but can perhaps be explained by the sap content in different parts of the leaf. I would expect first instar larvae to experience greater difficulty in establishing a dry overwintering gallery in the leaf base, with its concentration of water storage cells, than in the drier apical section. Spangehl (1933), working with *Agave parryi* var. *huachucensis* (Baker) Little, sampled sections from the apical, central, and basal portions of a leaf to determine the percentage of water (by weight) contained therein. His results were: apical section, 75%; central section, 85%; and basal section, 96%.

The directions a burrowing larva takes do not appear to be motivated by the food supply, but by negative and positive geotropism for the early and late instars respectively. This was demonstrated by inverting the foodplant and observing the change in direction of tunnels made by the larvae.

When mature the larva silked over the tunnel base and constructed a silk plate in the tunnel entrance, slightly below the leaf surface. This plate sometimes had plant matter incorporated in it. The combination of silk applied by the larvae and a rigid wound cambium formed by the plant around the tunnel wall, provided dry burrows in which the larvae underwent a quiescent period. Larvae in this resting stage responded to tactile stimuli, but were far less active when disturbed than were active-

ly feeding larvae. Quiescence lasted from two to twenty weeks. Larval activity was resumed during July, August, or September, depending on the population. The termination of quiescence appeared to be a response to lower temperature. Larvae kept in an air conditioned room terminated quiescence more rapidly than did larvae exposed to a higher outdoor temperature. No feeding occurred after the quiescent period.

The two characteristic larval activities between the termination of quiescence and pupation are the production of a white, soapy-textured powder and the construction of a trap door. The powder, which looks like asbestos under magnification, is produced on the ventral surface of the seventh and eighth abdominal segments. Dethier (1942) stated that four large rectangular areas, composed of simple unicellular glands lying just beneath the cuticle, secreted the powder. In noting the hydrofugic property of this secretion, he stated that its chief purpose was to create a dry environment for the pupa. The mature larvae of two other megathymid genera, *Megathymus* and *Stalingsia*, are known to produce this hydrofugal substance. Dr. H. W. Kircher of the University of Arizona obtained an infrared spectrograph of the powder produced by *Megathymus yuccae arizonae* Tinkham, for me. His results show that it is probably a ketone with approximately thirty-five carbon atoms. The spectrum is similar to that of stearone. The aid to survival contributed by this powder is questionable. The larvae of two agave-feeding genera in the Megathymidae, *Aegiale* and *Turneria*, do not powder their burrows (Stallings & Turner, 1958). Furthermore, I have found five living pupae of *A. polingi* and three of *A. stephensi* in burrows with no evidence of powder, indicating that survival is possible in these species when the powder glands do not function. It would appear that the silk and wound cambium making up the tunnel walls and the silk covering the entrance are alone effective in preventing the accumulation of moisture within the burrows.

The construction of a trap door over the entrance followed powder secretion (Fig. 4). Before making the trap door the larva removed the silk plug constructed prior to quiescence. It then proceeded to enlarge the narrow entrance to the diameter of the tunnel. In enlarging the entrance the remaining plant matter was dropped outside the tunnel as each bite was removed, very little being ingested if one may judge by the small amount of frass produced. Upon smoothing the perimeter of the hole

the larva applied the hydrofuge powder around the exit. The larva accomplished this by backing to the base of the burrow, turning around, then backing to the exit, where the powder was applied by pressing the glandular area to the tunnel wall and rotating the posterior portion of the abdomen. From time to time the larva would crawl down the tunnel, turn around, and return to the exit headfirst, where it further distributed the powder with the aid of the spinneret. In making the "door" the larva started at the upper edge of the hole, applying silk in a semi-circular pattern. The silk produced was in a much thicker strand than was used to line the burrow walls during the feeding period. Another property of trap door silk was that it remained viscid for several seconds after secretion so that it actually flowed into the adjoining strands and created a relatively smooth plate. Because the silk remained plastic the larva was able to smooth over weak places in the structure. The holes, measuring from four to nine mm. in diameter, were covered within thirty minutes, but the larvae could be seen through the transparent cover applying more silk to the inner surface. Only a weak attachment to the leaf existed at the perimeter of the trap door. From one to three days were required before the trap door acquired the color that is characteristic of the various species complexes.

PUPAE

Pupation takes place in the basal tunnel from one to two weeks after the trap door is completed. In the majority of the tunnels examined the pupae rested in the lower parts, separated from the base only by the exuviae. In rare cases the pupae were suspended by a few silk strands placed between them and the base. A few silk strands were generally present between the pupa and the trap door.

Movement of the pupae was evident only when they were disturbed. In contrast, the pupae of *Megathymus* show an adept ability for movement up and down their burrows through rotation of the abdomen and use of the cremaster as a brace. Pupil movement in the *Megathymus* is primarily a response to temperature changes; during warm weather the pupae move to the tunnel apex, while in cold weather they rest near the base. *Megathymus* tunnels have aerial and subterranean sections; therefore, it would be reasonable to expect significant temperature differences in the various portions of the tunnels. *Agathymus* tunnels are short in comparison to *Mega-*

thymus tunnels; as they are in most cases entirely above ground only slight temperature variation would be expected in different parts of a burrow.

Eclosion of the adults occurred from three to seven weeks after pupation, usually between the hours of seven and ten A.M. The adult leaves the pupal case through tranverse and longitudinal splits made in the head and thoracic region and then crawls up the tunnel to the trap door. By putting pressure on the trap door it ruptures the silk strands attaching the door to the leaf and causes it to swing open on a silk hinge or to fall off (Fig. 5). No silk digesting substance is produced. The adult next crawls onto the leaf surface where the wings are expanded to full size, usually within fifteen minutes. From one to two hours additional are required before the wings have attained sufficient rigidity to permit flight. In populations from which a large number of adults were reared most of the females emerged at a slightly later date than the males. However, the emergence dates of males and females overlapped to a certain extent and the first adult to emerge was sometimes a female.

NATURAL ENEMIES

The most obvious natural enemies of *Agathymus*, if we do not include physiological reactions of the foodplant, are other insects, particularly dipterous and hymenopterous parasites. A frequently encountered dipterous parasite was *Phorocera texana* Aldrich & Webber (Tachinidae). This fly was reared from *A. Aryxna*, *A. baueri*, *A. freemani*, *A. evansi*, and *A. chisosensis* (Freeman). Simpson (1957) did not record this tachinid from Arizona.

Townsend (1936) states, "The females of the *Phorocera* . . . deposit more or less incubated eggs directly on the host." But the life histories of many *Phorocera* are not known. Several tachinid genera are known to show variation in the type of reproduction and this may also apply to the *Phorocera*. Ingestion of the eggs appears to be the least probable method of parasitism because of the limited feeding *Agathymus* larvae do on the leaf surface. The deposition of eggs or maggots on the host is a possibility, although larvae are usually concealed in their galleries and no flies were observed near a gallery entrance. It is quite likely that maggots are deposited near the tunnel entrance where they can seek out the host in the burrow or attach themselves to larva when it defecates. I have not dissected gravid flies to determine whether they were bearing maggots

and/or eggs. Observations show the maggots emanate from the host during July, August, or September, and pupate in the burrow. The flies emerge about three weeks after pupation and have no difficulty in pushing open the trapdoor. The parasitized larvae often survive long enough to construct a trap door, but usually fail to powder their tunnels. Host larvae yielded from one to eight maggots. The occasional parasitized larvae that pupated never produced more than two maggots. Fall emergence of the flies, before *Agathymus* larvae are available as hosts, seems to indicate that other hosts are used. *Phorocera texana* was described from a series reared on *Melitara* (Phycitidae, Lepidoptera) taken at three localities in south-central Texas (Aldrich & Webber, 1924). I found no other host records.

A sarcophagid was also found to be an *Agathymus* parasite. This fly represented a new genus and was described by Dr. H. J. Reinhard (1963) as *Erucophaga triloris*. I reared it from *A. neumogeni*, *A. aryxna*, *A. baueri*, *A. freemani*, and *A. florenceae* (Stallings & Turner).

Many of the Sarcophagidae are scavengers during the larval stage, but the fact that parasitized larvae were encountered in burrows where the trap door was tightly closed indicates that this fly attacks living larvae. Sweetman (1958) states that most parasitic sarcophagids are larviparous, but a few deposit fully incubated eggs. Those that I collected pupated within the burrow, the adults emerging during September and October. Adult sarcophagids were often seen walking around on agave leaves, but the deposition of eggs or maggots was not observed. These flies showed a reluctance to fly and when disturbed usually ran to the underside of a leaf.

A new wasp, described by Dr. C. F. W. Muesebeck (1963) as *Bracon agathymi* was reared from *A. neumogeni*, *A. florenceae*, *A. mc Alpinei* (Freeman), *A. diabloensis* Freeman, *A. aryxna*, *A. mariae* (Barnes & Benjamin), and *A. alliae*. This insect was frequently encountered as a parasite of the *A. neumogeni* complex, but was rarely encountered on other species. On three occasions during May and June female braconids, presumably *B. agathymi*, were seen walking around entrances to larval tunnels. Oviposition was not observed. I assume the host is parasitized when it defecates because the wasp's ovipositor does not appear long enough to penetrate the leaf and burrow wall. When fully grown the braconid larvae leave the host and form a dense cocoon cluster. The cocoons, numbering from ten to forty

tightly plug the tunnel. Emergence occurred during June, August, and September. Larvae parasitized by this braconid either powdered their burrows and made typical trap doors; constructed weak, discolored trap doors and failed to powder the burrow; or died in the fourth instar.

Another wasp, determined by Dr. Muesebeck as similar to *Apanteles megathymi*, is to be described. This insect was reared from *A. stephensi* and an undescribed *Agathymus* which occurs in western Arizona. It is clear that the host-parasite relationships contribute no aid to clarifying the taxonomic status of *Agathymus* at the species level when the aforementioned cases are used.

Predators of *Agathymus* larvae were rarely encountered. Two beetles, probably *Cymatodera oblita* Horn (Cleridae), were reared from *A. arynna* and *A. baueri*. Two carabid larvae were taken while feeding on *A. polingi* larvae, but attempts to rear them failed. Small ant colonies were sometimes encountered in the basal tunnels, but it was not possible to determine if they entered the burrows as predators or became established after the original occupant died of other causes. While checking an *A. stephensi* population near Palm Springs, California, I noted that a number of burrows with trap doors had been gnawed into and the larvae or pupae removed. Only those burrows with a trap door on the under surface of the leaf were affected. Judging from the dung below those burrows the predator was a mouse.

Several insects, not to be considered enemies, were found in association with abandoned tunnels. Weevils of the genus *Scyphophorus* used the burrows to gain an entrance to the caudex of the agaves. A eumenine wasp, *Rygchium pratense* (Saussure), constructed mud-lined cells in old tunnels. Cells constructed of masticated plant matter made by bees of the genus *Ashmeadiella* were also encountered.

Diseased larvae were frequently found, but the causal agent was not determined. Four *A. freemani* larvae taken near Bad-dad, Yavapai Co., Arizona, were covered with a fungus (*Metarrhizium*?) that produced green conidia. It was not possible to determine whether this fungus caused larval mortality or was merely a saprophyte.

No examples of cannibalism were noted, even when a large number of first instar larvae were closely confined. Larvae at times would chew through the wall of an adjoining tunnel while

making their basal galleries. Under these circumstances a silk partition was made and feeding resumed.

As is to be expected, the mortality rate varied widely at the population level. The highest mortality rate due to natural agents was encountered in an *A. florenceae* population near Mt. Locke in the Davis Mountains of Texas. An examination of 350 basal tunnels in late May yielded the following: 311 tunnels approximately three cm. in length which gave evidence that third or fourth instar larvae had been "sapped out" and had failed to become established elsewhere on the plant; 20 dead fourth instar larvae trapped by sap; six diseased larvae with symptoms suggesting a polyhedral wilt; eleven larvae actively feeding as evidenced by fresh frass deposits at the burrow entrance; and two tunnels which were sealed in such a manner as to indicate that they contained moulting or quiescent larvae. Two feeding larvae and one quiescent larva were removed for preservation and ten living larvae left. On a large plant which contained six living larvae a female *Bracon* was observed running around a frass pile at the entrance to a tunnel. This parasite did not attempt oviposition during the fifteen minutes of observation, so was then collected. During September, four months after they were first located, I checked the ten living larvae, with the following results: three tunnels contained braconid cocoons, three contained larvae covered with a fungus, three contained pupae which later produced adults, and one tunnel contained a puparium from which a sarophagid later emerged. The mortality of fourth and fifth instar larvae attributable to the braconid varied from 0 - 63% in Arizona populations of *A. neumoegeni*. Mortality caused by *Phorocera texana* varied from 24 - 90% in *A. freemani*, 6 - 40% in *A. baueri*, and 0 - 45% in *A. aryxna*, based on larvae collected and held for rearing in the fifth instar.

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W. H. EDWARDS' LIFE HISTORIES OF NORTH AMERICAN COENONYMPHA¹

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ONE OF THE UNFULFILLED DREAMS of William Henry Edwards was to publish a volume devoted to the life histories of all of the North American Satyridae. To this end, he made special efforts to urge his many friends, who supplied him with butterflies and eggs of butterflies, to send him material. He had Mrs. Peart draw many illustrations for the proposed volume. The results of Edwards' studies are found in twenty-four notebooks. Apparently there had been twenty-six in the series. Volumes "L" and "T" are missing. The surviving notebooks are preserved in the archives of the State of West Virginia, Charleston, West Virginia. In the same collection is a portfolio containing Mrs. Peart's unpublished drawings. Through the courtesy of Dr. James L. Hupp, historian and archivist for West Virginia, and the cooperation of the Library of the University of West Virginia in Morgantown, I have had prepared a microfilm of Edwards' journals. From these I have copied and presented below Edwards' accounts.

Edwards published accounts of the life histories of two *Coenonympha*. In the Canadian Entomologist for 1887, (19:41-44), he described the early stages of *insulana* McDunnough as *ampelos*. His several batches of eggs came to him from the vicinity of Victoria, Vancouver Island. In the third volume of the Butterflies of North America, he published his account of the life history of *california* Doubleday based upon eggs from Berkeley, California. In this account he proved that this butterfly was double-brooded and that the names *galactinus* Boisduval and *california* referred to these broods.

In addition to these published accounts, Edwards' Journals contain partial or complete accounts of the early stages of five other *Coenonympha*. In Journals N, P and R, are incomplete accounts of *ochracea*, Edwards raised from Colorado eggs. In

¹ This study was supported by N.S.F. Grant GB-194.

Journals R and T, (the latter now lost), are accounts of *benjamini* McDunnough (as *inornata*) from eggs laid in Montana. A complete account of the life history of *elko* Edwards from eggs collected on the Weber River in Utah is found in Journals R and S. Also in Journal S is a partial account of the Great Basin strain of *ochracea* or a cryptic species related to *elko* (as *pamphiloides* Reakirt) that is incomplete. And lastly, in Journal W is an incomplete account of *haydenii* Edwards from eggs procured from Yellowstone Park females.

Since these unpublished accounts, complete or incomplete, contain information of considerable importance, I have brought them together. I have changed the accounts from verbatim in only three ways. I have used a uniform system for noting the dates, instead of the several that Edwards used. I have spelled out abbreviated words. I have altered the punctuation from series of statements separated by colons, to the same wording separated by commas, colons and periods for sake of more clarity. Thus the work is that of Edwards. Dr. Hovanitz agrees with me that the authorship must be that of Edwards, I have merely contributed an introduction.

COENONYMPHA OCHRACEA Edwards

Edwards worked with four lots of eggs from the Mountains of Colorado.
 1884, Journal "N", pp. 77, 111-117, eggs from Nash at Rosita, Colo.
 1886, Journal "P", pp. 53-57, 126-127, 156-161, eggs from Bruce at Denver, Colo.
 1888, Journal "R", pp. 38, 160-161, 174, eggs from Foster at Salida, Colo.

The following descriptions of Colorado material are those Edwards selected as best fitting each instar. Bracketted notes by Brown.

June 30, 1886. . . . Received eggs of *Coenonympha ochracea* today from Bruce, Denver, laid 23 June. There were 25 eggs and 2 larvae just out of egg. (The eggs began to hatch 2 July, or 9 days. The 2 larvae must have been from eggs laid earlier).

EGG: Conical, the top truncated so as to be broad, flat and covered with a flat net work of irregular meshes, very fine about the micropyle, the sides ribbed with fine ribs from the edge of top 5/8 the way down, there are about 40 of them. Below these to the base covered with fine irregular net work. The base well rounded. Color when laid yellow-green, after becoming brown. [N. B. Mottled with brown. F. M. B.].

[First instar, from 1884 account]. . . 10 or 12 hours after egg: Length 1/10 inch: same shape as *Chionobas*, thickest in anterior, slight (very little) tapering from 3 and 4 to end. 13 ends into conical tails meeting at the base, each of which ends in a white bristle. Color yellow white with longitudinal red lines: one fine one mid-dorsal, one heavier subdorsal, one finer mid-lateral. Under side, feet and legs the same color as the rest of the body. On the dorsum are very short, curved down, clubbed white hairs, one to each segment on each side of mid-dorsum. Head obovoid, truncated, a little depressed at suture, the vertices rounded: 1/2 broader than 2: color dark brown, the space over mandibles and the triangle over mandibles yellow brown: a few bent-down, short, clubbed white hairs. Ocelli are black.

[Duration of first instar: 1884, 11 days; 1886, 9 days, 1888, 10 days].

[Second instar, from 1886 account] Description at 24 hours after 1st moult. Length 17/100 inch. Tapering from anterior segments to end, the tails conical, separated at base, reddish at ends. Color of body yellow green, thickly covered with fine white tuberculations. A mid-dorsal dark line, blackish; another like it on mid-side (too low to be called subdorsal); along base a white stripe; next above this a blackish one of paler color than the side stripe and wider, this is separat-

ed from the side stripe by a space broader than said lower paler stripe and in the middle of such space seems an indistinct dark line, as if a line would come out there as the larva grew. Under side, feet and legs paler yellow green. Head apple green, subglobose, narrower towards top, somewhat flattened frontally; ocelli black.

[Duration of second instar: 1884, 13 days; 1886, 16 days; 1888, 17 days].

[Third instar, from 1884 account] Fifteen hours after second moult: Length 24/100 inch. Color green, the body whitish green with dark green bands and stripes. Under side, feet and legs one shade of light green. A medio-dorsal band of dark green, edged a little by yellowish; high on the side is a green line, under this to the basal ridge the side is occupied by two bands of equal width, the upper one like the dorsum, the narrow [lower?] one dark green. The basal ridge is yellow. The shape is thick anteriorly and tapered to the end, tails as before. Head emerald green, thickly beset with minute yellow tubercles. The body is much dotted with similar tubercles also. Mrs. Peart notes of the larva after third moult (of which she made drawing) "tubercles white, processes black, all turned back except on 2nd segment. The head covered with white tubercles with white processes". These processes are what I have called hairs.

[Duration of third instar: 1884, 17 days; 1886, 31 days; 1888, 30 days].

[Fourth instar, from 1886 account] Aug. 27. One larva passed third moult last night. Length 12 hours after, 33/100 inch. Shape as before, slender. Tails as before, pink. Color yellow green, dotted all over with white points. Mrs. Peart says of larva after 3rd moult: "This stage is covered with white tubercles with short (stumpy) black hairs: the head rough with white tubercles and white hairs. These little hairs (on body), short as they are, all lay back after 2nd segment". On mid-dorsum a dark green stripe. There are traces of two others to the basal ridge, this last yellow. Under side, feet and legs yellow green. Head subglobose and as before: dotted with white points: deeper green than body.

[The larvae went into hibernation sometime after the third moult, while in the fourth instar. In 1884 Edwards placed the larva in a pillbox inside another box and buried this in a pile of rocks in the woods behind his house on November 5th. He retrieved the larva on February 28, 1885. This larva did not pupate. In 1886 the sole remaining larva hibernated on October 27th and was put out of doors for the winter. It was brought in on February 1st, 1887. It survived to pass a fourth moult which is described below. In 1888 Edwards sent the hibernating larvae to his daughter Edith, Mrs. Theodore Mead, to be placed in an ice-house at Clifton Springs, New York. He received them back, living, on April 16th, 1889. These larvae too passed a fourth moult but did not pupate].

[Fifth instar, 1887 and 1889 accounts] Feb. 14, 1887. Larva passed fourth moult last night. Feb. 15. Larva is considerably smaller than before the moult. Length at 12 M. 4/10 inch. Shape as before. Color yellow green, owing to yellow tubercles - decidedly yellow-green. A dark green mid-dorsal stripe, one like it in all respects on mid-side, an indefinite one a little below this, and then the basal ridge, quite yellow. Feet, legs and under side deep green. Tips of tails red. Head emerald green. (The whole upper surface is one shade of yellow green now, not banded in different shades.) Feb. 22. Measured 62/100. The lower half side more green, less yellow, owing to obliteration of the tubercles, while the whole dorsal area is dark green and the basal ridge is less yellow, more green. Perhaps these changes precede pupation pretty closely. Larva thickest on 7-9, then lessening to ends. Mar. 5. Same size. Seems to rest quietly nearly all the time, but weather at present is not clear or warm. The marks vary a little from my late description and I re-describe them. A dark median band, edged lightly with yellow on either side by reason of condensed yellow tubercles. On the side, equidistant from the mid-band and basal ridge, a narrow stripe, nearly as dark as the mid-band, and edged with yellow in the same way but lower side only. The basal ridge yellow. Apr. 28. This larva died today. In 6 weeks it had remained quiet and of late became smaller day by day and so departed.

May 11, 1889. One larva passed 4th moult last night. Length at 7 A.M. 38/100 inch, contracted. All whitish green, upper and lower sides, feet and legs about the same shade. The surface covered with fine white tubercles, so is the head. A pale yellow basal stripe or line. I had a charon pass 3rd moult at the same time and the two were essentially alike, except that charon has lateral green stripes and the other not. Length at 4 P.M., say at 12 hours from 4th moult, 4/10 inch. As described above but also a darker mid-dorsal narrow stripe and two such laterals separated by their own width of the ground (whitish-green). Under side, feet and legs green. Tails red at ends, separated at base, one standing in line with each side of the body. Head yellow green. May 13. In 2 days I have missed one of these larvae and count it lost. May 20. I sent this larva to Mrs. Peart, being mature. She says "This and charon are much alike, but charon is more yellow, and on ochracea is a dark line of green above the upper light line. On charon the dark line is below the upper light line. The processes on ochracea are black: on charon white, with black at top of tubercle". Letter of 26 May.

COENONYMPHA AMPELOS Edwards

[Edwards published an account of the early stages of "ampelos" in the Canadian *Entomologist* (1, c.). After this he received several more batches of eggs. Nothing in later notes add to the published information. The journal accounts are found in: 1885, *Journal "O"*, pp. 28-88 intermittantly, 180-193, 196-197, 210, eggs from James Fletcher, Victoria, Vancouver Island, B.C., two batches.

1886, Journal "P", pp. 9-40 intermittantly.

1890, Journal "T", pp. 53-95 intermittantly, 216-217, 224-225, 275, eggs from Danby, Victoria, B. C. This journal has been lost.

1891, Journal "U", pp. 16, 24, 26, 29.

1892, Journal "V", pp. 40, 41, 52, 175, eggs from Danby, Victoria, B. C.

[These accounts apply to insulana McDunnough.]

COENONYMPHA INORNATA Edwards

[Edwards's Journals carry two accounts of the early stages of inornata. One of these, the earliest, applies to inornata inornata, the second to inornata benjamini McDunnough. The account of the latter has been lost. It was in Journal "T". This is unfortunate since Edwards was successful only with benjamini. He lost the larvae of inornata during hibernation. The account, as far as it goes, is in 1888, Journal "R", pp. 180-184.]

[Davenport (1941) was successful rearing inornata inornata. His description is scanty and incomplete. Therefore it is important to publish Edwards's notes.]

Aug. 15, 1888. Received eggs of this, laid at Ottawa, from Fletcher. Eggs shaped and ribbed as in ochracea.

Aug. 18. Three larvae out this morning, one died later. Length at six hours, 1/10 inch. Shape as of the genus, thickest at 2 tapering to end, ending in two blunt tails. Head subglobose, twice as broad as 2, yellow-brown. Body gray white on dorsum and upper sides. A mid-dorsal and subdorsal red-brown line and one below spiracles. Under side, feet and legs yellowish. Later: I see three brown lines, the subdorsal, mid-lateral and a lower lateral marking the three close together.

Aug. 19. Two larvae feeding. Color changed to pale or apple green, upper and under sides. The brown lines distinct, but the middle one of the three faintest.

Aug. 31. Both larvae pass first moult.

[Duration of first instar: 13 days. Davenport's ranged from 11 to 19 days.]

At first moult [second instar]: length at 24 hours, 14/100 inch: shape as of ochracea. Color blue-green, finely tuberculated short hairs from each tubercle. Color of tails red. A dark mid-dorsal line and three such on side, close together. Under side, feet and legs green. Head yellow-green, subglobose, tuberculated and like ochracea. In N 210 ochracea is described as having but one lateral line, in P. 157 another description speaks of three stripes on side, not so definite as in this inornata.

Sept. 12. One larva has passed second moult, 2 P. M.: other swollen for same.

Sept. 14. The second larva passed second moult.

[Duration of second instar: 12-14 days. Davenport's ranged from 14 to 27 days.]

Description 12 hours after second moult [third instar]: Length 2/10 inch. Green, covered with fine yellowish sharp tubercles, each with short fine hair. A dark stripe mid-dorsal, one narrower subdorsal, a line just below it and one as broad as mid-dorsal over the basal ridge, this last pale yellow. The stripes are clear of tubercles or any hair. Under side, feet and legs green. Head subglobose, light green, much covered with small yellowish tubercles.

[A marginal note describes this stage of benjamini, q. v.]

Sept. 21. One larva has disappeared.

Sept. 27. For two or three days the other larva has been lethargic. I sent it today to Clifton Springs. On the 19th the length was 22/100. Came back from Clifton Springs on 16 April, 1889.

May 6, 1889. Passed third moult in the night.

[Description of fourth instar:] At 7 A. M. length 2/10. Color whitish-green, the light color caused by innumerable fine white tubercles over upper surface, tails reddish. A dark green mid-dorsal line or narrow stripe free from the white tubercles, two lines on the side separated by a line of equal width of the ground color (whitish-green), then a band of green, and next the pale yellow basal band. Under side, feet and legs green. Head shaped as before, yellow-green, thickly covered with white tubercles.

May 7., 4 P. M., larva 24/100. The above description is good now.

June 5. Only 29/100 in length. Feeds a little and looks healthy. There is a black spot on top of head as if there had been a wound and blood coagulated, but the body is healthy, apparently.

June 8., 1 P. M., passed fourth moult. The black spot is not on the head now and the larva looks healthy.

June 9. Description of larva after fourth moult, fifth instar, one day. Length 26/100. Green, covered with fine white tubercles as before. A darker mid-dorsal line, two such, or narrow stripes, on side as at last previous stage, and a band, same as then also, over the ridge, ridge yellow white. Under side, feet and legs green. Head as before. In fact the larva looks just as at last stage previous.

[Duration of fourth instar: 33 days. Davenport's third instar of 19-26 days preceded hibernation.]

July 8. Length 31/100. In more than a week this larva remained absolutely quiet. I had cut off the leaf of grass (I see it was 23 June) and laid it cross-wise on a fresh plant and there the larva has rested up to this date, evidently asleep.

July 16. I sent this larva to Clifton Springs in a pillbox for hibernation. It was about 26/100 long and had not stirred for almost a month. This larva died during the winter.

COENONYMPHA BENJAMINI McDunnough

[During 1890-1891, Edwards observed the entire series of early stages of inornata benjamini. These he recorded, as inornata, in Journal "T", one of the two lost journals. A summary of the timing is found in Index Volume II on P. 68. The eggs were received from William G. Wright who collected them at Maiden, Montana. I present below Edwards's time-table for benjamini and his description of the third instar which is to be found as a marginal note on P. 182 of Journal "R".]

July 13, 1890. Received six eggs.

July 14. Received more eggs.

July 16. Eggs hatching.

July 23. First moult.

Aug. 1. Second moult.

Aug. 29. One passed third moult.

Sept. 1. Another passed third moult.

Sept. 7 and 23. Larvae hibernating and sent to Clifton Springs.

Feb. 16, 1891. Three larvae survived the winter.

Mar. 3. One larva passed fourth moult.

Apr. 7. One larva suspended and pupated.

Apr. 23. An imago emerged.

[Description of third instar:] Length 24/100. Color green, with whitish effect from the fine whitish-yellow tubercles. A dark mid-dorsal stripe (green) and the whole side below the dorsal area the same dark hue, cut by two lines of light, so as to make two equal green stripes and a green band over the ridge, ridge pale yellow.

COENONYMPHA ELKO Edwards

[During 1889-1890, Edwards successfully reared elko from egg to imago. The descriptions of the various developmental stages differ sufficiently from those of insulana McDunnough, the only other member of the ampelos complex for which they are known, to support taxonomic segregation of elko. There is a distinct possibility that there are two cryptic species involved in what we call elko. One of these is double brooded (elko proper) and the other single brooded and called pamphiloides Reakirt by Edwards. Someone living in Utah or southern Idaho should attempt to unravel this tangle. It will mean raising a good many broods from each seasonal appearance of "elko". Currently pamphiloides Reakirt is considered based upon mislabeled specimens of European pamphilus Linnaeus, a double brooded species. Edwards's notes on the partial life history of pamphiloides are else where set forth in this paper.

[Edwards's records for elko are found in Journal "R", 1889-1890, pp. 96-99, 201-213, 226-227 and Journal "S", 1890-1891, pp. 107-108.]

June 14, 1889. Received 18 eggs laid 7 June from W. S. Foster at Weber River Cañon, [Utah.] He says the butterfly is found along the bottoms on Weber River and not in the mountains.

June 16. Received about 30 more eggs, sent on the 10th, laid between 8th and 10th. Mrs. Peart compared egg of elko with ochracea and found it similar to the latter, but the vertical ribs are only 1/3 the length of the egg. - Letter Dec. 10, 1889. -

June 17. The first lot hatched. Description of larva [first instar:] Length 8.5/100 inch. Tapering gradually from 2, ending in two little tails, like the genus. Color pinkish white, a red-brown mid-dorsal line and three such lines, rather finer, on the sides, equidistant, the upper making the sub-dorsal line. Feet and legs whitish. Head subglobular, yellow-green.

June 18. At 24 hours. Length 11/100. Changed to green: feet and legs whitish: the lines have lost there decided reddish color and are a little darker only than the ground color. The body has filled out so that 2 to 7 are equal, then tapering. Head now pinkish brown. Mrs. Peart says of young larvae: "The stripes are paler than on any other species, and now since eating, the green nearly obliterates the pale brown. Tubercles same as ochracea."

[Duration of first instar: 6 days.]

June 23. Two passed first moult about 10 A. M. [Second instar] at 3 P. M.: Length 17/100. Green, covered so thickly with white tubercles as to appear whitish green. Green mid-dorsal and subdorsal lines, a lateral, same width, a little below the subdorsal (they separating a whitish green line equal in width to one of the green ones), then, at equal distance, a broader (twice as broad) green one, and then the yellowish basal ridge. So there are three green lines or stripes on the side, including the subdorsal. Under side, feet and legs green, pale. Tails pale, a whitish green. Head subglobular, bright green, much covered with white points. Ocelli dark. The points on body give very short and fine hairs, with difficulty seen.

June 24. Length 24/100. Tails now red, otherwise as yesterday.

[Duration of second instar: 6 days.]

June 29. Two larvae passed second moult at 4 P. M. [Third instar.] An hour after, length 3/10, 32/100. Whitish green, from the white tubercles. Head emerald green, broader than 2. From 2 dorsum slopes and increases, narrowing again after 6 and sloping to last.

July 5. Two have passed third moult.

[Duration of third instar: 6 days.]

July 6, 24 hours after third moult. [Fourth instar.] Length 54/100. Shape as before: head a little broader than 2. Color whitish green, the green longitudinal lines faint, basal yellow, tails red. Under side, feet and legs bluish green. Head dull yellow-green, with many white tubercles.

July 10. [Fourth instar.] Length 94/100. Slender, thickest in middle, tapering each way, anterior gently, rapidly to 13. The tails red. Color yellow green, the mid-dorsal stripe dark green, the side stripes nearly passed away, only the subdorsal (or upper lateral) showing faintly, the basal ridge yellow. The surface thickly covered with white points, from each a very short hair, or bristle. Head darker green than body, with white points.

July 12. [Fourth instar.] One larva at third moult comes up red, all the rest being green. Description of red larva: length 64/100 inch (I don't know when it moulted.) Color red from 3 to 13, 2 being green and dorsum of 13 is green, but ends of tails are red. A brown mid-dorsal band edged on either side by faint yellow - a mere touch. The only stripe on the side may be called subdorsal, or upper lateral, brown also, narrow and edged on lower side only with faint yellow. Under side green-brown, feet green, legs shade of brown on green, less decided than the venter. Head dull green.

I sent this to Mrs. Peart. Later in the day I got a card from her saying that the single larva she had turned up red after third moult, "green and brown with a pretty pink tint on the surface." This was on second day. It was then green just after the moult.

July 14. Length 94/100. At 3 P.M. one larva has suspended in form of figure 6 and another is about to do the same.

July 15. One pupated at 11 A.M. Two others are suspended.

[Duration of fourth instar: 9 days.]

July 16. Descriptions of chrysalis.

No. 1 Length 42/100. Shape of *ampelos*. The mesonotum rises to an angle. Color yellow green, four black longitudinal stripes: one curved on the middle of the wing case, one at dorsal edge of wing case from the shoulder and this has the color next to it on the wing whitish in a narrow space. No. 2 Length 42/100. Color whitey-brown, lightest anteriorly, with a greenish tint, the abdomen quite brown. The four stripes are merely darker than the ground color, no decided color. This came from a green larva.

No. 3 Length 44/100, breadth of abdomen 16/100, of mesonotum 16/100. Color green, the black stripes as in No. 1, but in addition one on the ventral side between the tongue cases to the end of same, as long as the stripe on the middle of said cases, between this and the middle stripe a very short one, or a streak, just within the margin; two short stripes on the antennae cases; so there are in all 9 as in *ampelos*. The description of *ampelos* answers for this, except that the mesonotum seems more angular and there are no black marks on 13.

No. 4 Pupated 17th July in P.M.: Green, four black stripes very narrow, mere lines. Length 4/10, breadth of abdomen 18/100 inch.

No. 5 Pupated 20 July. Length 4/10, breadth of abdomen 16/100 inch. Green, four marks only, very slight and pale, just like No. 4.

Mrs. Peart wrote on 29th: "The *elko* chrysalids are exactly like *ampelos* in outline, I think. Two of mine have the stripes so pale as scarcely to show. The color of all differ. The one (green) you sent me pupated 15th, gave imago 24th July." Mrs. Peart says a green larva pupated 10th [August.] This pupa is large, striped and mottled gray, quite different from any other I had.

[Duration of pupal period: 8 to 9 days.]

COENONYMPHA "PAMPHILOIDES" Reakirt"

[In 1889-1890 Edwards raised into the third instar a *Coenonympha* that he called *pamphiloides* Reakirt. His experience with this butterfly is recorded in Journal "S", pp. 104-108, 232. There is some confusion about whether or not he was successful in bringing this species to the imago.

What emerged from the pupa of unknown sources was a specimen that Edwards considered *elko*. I suspect that it was his "*pamphiloides*." As I suggested under *elko* there is a riddle to be solved.] June 28, 1889. Eggs received from Foster, Ogden, Utah.

June 30. Larvae hatching. Three hours after eggs: length 12/100. Shape of the genus, color pinkish white, a red-brown mid-dorsal line, a subdorsal line and two below, equidistant as usual. Head twice as broad as 2, yellow-brown, with scattered white tubercles, shape of the genus, Mrs. Peart says of young larvae: "Just like *ochracea*, shape of head, tubercles, etc.: color not so yellow, the stripes very pale, and with the first eating took on a green tint. They are now quite green, the brown lines scarcely showing."

July 8. Three larvae passed first moult in the night. Length at 7 A.M. 18/100. Shape of the genus, tails red, color green thickly covered with yellow points, basal ridge yellow. A broad line, mid-dorsal, of dark green, three on the side as on *ochracea*, *elko* and the rest. Head subglobose, emerald green, with yellow points (as on the other species). Under side, feet and legs green, 3 P.M. Two more larvae have passed 1st moult, in all 5 today.

[Duration of first instar: 10 days.]

July 9. 7 A.M. at 24 to 30 hours from moult: length 2/10 inch. The green lines dark and distinct. On the side three lines, the lower one indistinct and lying next over basal ridge.

[Duration of second instar: 8 to 18 days.]

July 18. Larvae passing second moult. One passed same on 17th. This A. M.: length 3/10 inch; green; tapering from 2, tails reddish; the stripes, mid-dorsal and lateral, faint, a little darker than the ground; basal ridge yellow.

Aug. 7. Length 4/10 inch. Mrs. Peart had two pamphiloides pass second moult 23 July and 26 July.

Aug. 3. One pamphiloides passed third moult.

Aug. 13. Another passed third moult.

[Duration of third instar: 16 to 26 days, or into hibernation before third moult.]

Aug. 23. There are five larvae. Two of them 44/100 and 5/10 inch. These may still be active, but the other three, not yet at third moult, seem quiet and I have today moved them to pillboxes to test that.

Sept. 1. One larva passed third moult and later died. I have two larvae in hibernation.

Sept. 19. Sent larvae to Clifton Springs.

1890

I sent to Clifton some larvae of this species["pamphiloides"] and also elko. These came back, one larva only alive, and I got the labels mixed and so do not know which species it is, but it has passed the first moult since hibernation this day, 24 April, 9 A. M. [An added note reads "Elko and The larva was elko"]

Apr. 26. At noon 6/10 inch: thick anteriorly, tapering to end: the two tails red-tipped. Coloring yellow green, the dorsal stripe darker and the side stripes all faint, basal ridge yellow. Feet and legs and under side are darker green than upper side. Head emerald with many yellow points. The body is covered with fine yellow points, from which very short, light and fine hairs. I sent this larva to Mrs. Peart this day.

May 23. Mrs. Peart writes that this larva pupated 14th. Pupa green - an emerald green near head case - and is nearly like ampelos. It is a little larger. There is no dash of black on either side of the cremaster, which shows in all ampelos. Ampelos is not so bright, but of three ampelos no two are alike.

May 30. Received the imago of this larva and it is elko. Pupated 14th and out 26th.

[It is to be noted that the eggs that Edwards thought from "pamphiloides" were laid in late June, about two weeks later than were the eggs of elko. The June eggs of elko produced a late summer brood. The eggs of "pamphiloides" produced larvae that hibernated in the third instar. Several larvae of elko transformed slowly and, except for one, died in August. The exception was sent to hibernation. In the light of my own experience with larvae of *Coenonympha* I suspect that the larva that died during hibernation was this laggardly elko and that the survivor that went to imago was a "pamphiloides". The general appearances of the imagoes of European pamphiloides and the ampelos-elko complex are such that they are more easily confused than are ochracea imagoes with either of them. As I suggested above, patient life history work with what we now consider elko may well prove that there are two species involved, one single brooded ("pamphiloides") and the other double-brooded (elko). The single brooded species may be a southern relative of columbiana McDunnough, now considered to be a northern single-brooded subspecies of ampelos.]

COENONYMPHA HAYDENII Edwards

[In 1896 Edwards had partial success rearing *Coenonympha haydenii*. It was this experience that confirmed placement of this odd species in the genus *Coenonympha* rather than in *Erebia* where Edwards placed it in his original description and in the third volume of the *Butterflies of North America*. In the index to that volume he altered the generic placement to *Coenonympha*. The plate figuring haydenii was released May 28, 1888, and the index March 1, 1897, or later. Edwards's notes are found in Journal "W", pp. 168, 220-222, 224.]

July 28... Received 5 eggs of *Coenonympha haydenii*. Dr. William Barnes took several females in Yellowstone Park and brought them to Denver, and gave them in charge to Ernest J. Osler to get eggs and send to me. He says he got and sent 6. The first was laid 20th, sent 24th. I have sent two to Mrs. Peart.

Egg: Conical, rounded at bottom, largely truncated at top and flattened. The upper part of the sides marked by many fine ribs, vertical. The basal part, below ribs, marked with shallow cells.

Mrs. Peart says, 31 July, the egg of haydenii is that of a *Coenonympha* and not of an *Erebia*. The top is somewhat flattened, covered all over with a fine net work. The ribs of the side are separated by flat spaces crossed by light ridges rather irregularly. I think scarcely distinct enough or regular enough to be called striae. The ribs are very numerous and fine. I make out 68 or 70. These ribs do not continue to the base, but end about 1/4 of the height from the base in a surface of indentations not very sharply defined as to shape. It is very much like ochracea but the ribs are more numerous and the net work of the top finer.

July 30. Three larvae out about 9 this A. M. One egg collapsed. Length 12/100 inch an hour after. Color white with faint tint of green, the lines pale brown, a dorsal broadest, and two lateral. The dorsal is nearly twice as broad as the lateral. The under side, feet and legs greenish white. Head the color of the body.

July 31. Description of larva one day old. Length 14/100. The shape of *galactinus*, head considerably broader than 2. Color green-yellow, body now becoming green, a greenish-white. The dorsal and two lateral brown lines. Segment 13 ends in two conical tails.

Aug. 1. At two days, length 16/100, more green, a delicate, pale green. There are but two larvae and they are alike. Mrs. Peart says the young larva is like *Coenonympha*, also the form segment 13, with its two prongs is the same as on *ochracea* and *pamphiloides*. The *Erebias* terminate bluntly.

Aug. 7. The one larva passed its first moult at 4 P. M. It looks like the genus *Coenonympha*. There was a second larva, but a few days ago I missed it and on searching through the sod, I found a very active whitish larva, with black head, running up and down the grass leaves as if searching for something. No doubt this fellow has eaten the *haydenii*. Of course I killed him then and there.

Aug. 8. Description of larva one day after first moult [Second instar] Length 21/100. Thickest anteriorly, tapering to 13, which ends in two conical tails. Color green, surface of the upper side wholly covered with fine whitish tuberculations, each with a white downy short hair. The mid-dorsal stripe missing these [tubercles] and is green, dark. But one line is yet apparent on the side (as the larva grows will become more distinct). The basal ridge is yellow white. Under side, feet and legs whitish, translucent. Tails reddish. Head a little broader than 2, subglobose, green with many fine white tubercles and hairs from same.

Aug. 9. Two days after first moult. Length 28/100. All green now, the gray or whitish appearances of yesterday lost. The dorsal stripe green. Only one side line, dark green.

Aug. 28. My larva has died trying to pass its second moult, and yesterday I received a note from Mrs. Peart that the one she had had just died at the same point. Therefore, we have failed for this year.

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- . 188. "Coenonympha I - *Coenonympha galactinus*." Butterflies of North America, 3: [219-223,] Pl. *Coenonympha* I., est. pp. 220-223, and figures *a* through *g*.

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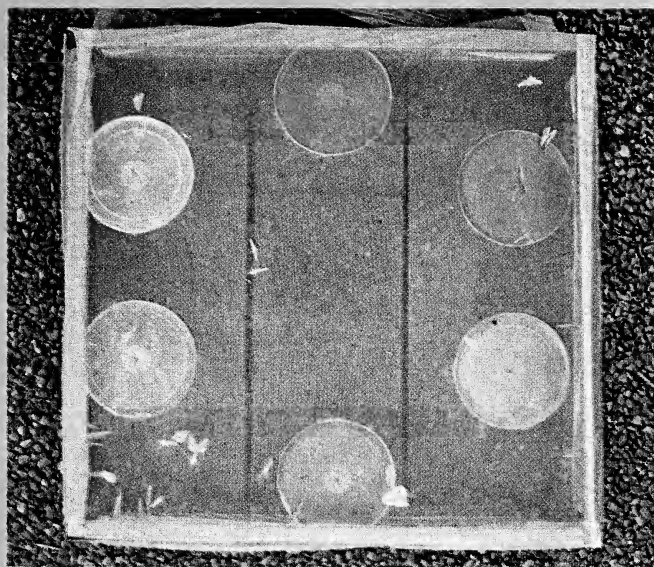
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THE PURPOSE OF THE JOURNAL is to combine in one source the work in this field for the aid of students of this group of insects in a way not at present available. THE JOURNAL will attempt to publish primarily only critical and complete papers of an analytical nature, though there will be a limited section devoted to shorter papers and notes. QUALITY WORK on any aspects of research on the Lepidoptera is invited. Analytical and well illustrated works are preferred, with a minimum of long description.

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THE JOURNAL is not a suitable place for continued changes of nomenclature; unless the author is himself analytically studying a group from its biological point of view and finds a change necessary, the editor must ask authors to refrain from any changes from the McDunnough Check List unless superseded by a monograph published since that date. Popular books are not to be considered as giving scientific credence to any name. It is rare that name changes need be made and preference is given to old names unless in the editor's opinion sufficient evidence is given to warrant such change.

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REVISION OF THE NORTH AMERICAN GENUS *BEHRENSIA*

WITH A DESCRIPTION OF A NEW SUBSPECIES

J. S. BUCKETT

University of California
Davis, California

THERE HAS BEEN NO COMPREHENSIVE work on the unique, little-known genus *Behrensia* Grote. This genus is represented by *conchiformis conchiformis* Grote, *conchiformis suffusa* Buckett and *bicolor* McDunnough, the type species being nominate *conchiformis* Grote. This revision contains redescrptions of the genus, redescrptions of the two previously contained species and complete synonymy, description of a new subspecies, descriptions of the fifth instar larva and pupa of nominate *conchiformis*, photographs of the adults, illustrations of the genitalic organs of both sexes in each species, and additional distribution for each species.

The genitalic mounts were prepared using lignin pink stain and balsam as the mounting media, the lignin pink being employed to better contrast weakly sclerotized areas. In the female genitalia the bursa was inflated; in the male, the aedeagus has been removed from the remainder of the genitalia for clarity of illustration. The genitalic illustrations were prepared by aid of a bioscope, additions and/or corrections being made by use of a dissecting microscope. The genitalic illustrations were all drawn to the same scale.

Literature dealing with *Behrensia* reveals a description of the genus and a description of each species, drawings of the wing venation and portions of nominate *conchiformis* Grote (Hampson, 1906), a photograph of a rubbed specimen (Holland, 1903), and a very poor painting of *conchiformis* in Draudt's work (Seitz, 1923). Evidently the internal structures have not yet been illustrated and nothing to my knowledge has been published on the immature stages of any members in the genus.

At this time, I wish to extend my appreciation to Dr. W. Harry Lange, Professor of Entomology, University of California, Davis, for reviewing the manuscript, and for his many helpful suggestions. Many thanks are also due Miss Judith Jay, De-

partmental Artist for the Entomology Department, University of California, Davis, for the illustrations. I am also indebted to Mr. A. Noel McFarland of Valyermo, California, for the fifth instar larva and pupa of nominate *conchiformis* as well as for his notes on the larval habitus of this species. Special thanks go to Mr. Lloyd M. Martin of the Los Angeles County Museum and to Dr. C. Don McNeil of the California Academy of Sciences for the loan of all specimens of *Behrensia* contained in their institutions.

The specimens used in this study were from the following institutions:

1. Bauer-Buckett collection, Davis, California.
2. California Academy of Sciences, San Francisco, California.
3. Entomology Collection, University of California, Davis.
4. Los Angeles County Museum, Los Angeles, California.

Behrensia Grote

Behrensia Grote, 1875. Type species *conchiformis*. Canadian Ent. 7:70.

HEAD sunken; antennae simple, dorsal row of scales light colored, ventrally with microciliations, ciliations becoming longer terminally, large tufts of hair from scape; eyes rounded, lashed, naked; palpi obliquely upturned, 3rd segment one half the length of second segment; proboscis normal. THORAX with collar composed of porrect spatulate hairs, protruding forward over head; metathorax with divided crest; mesothorax with narrow divided crest; legs clothed in brown hairs; each tarsal segment predominantly black, remainder white banded. Primaries short and broad, main veins developed into dorsal ridges; R_1 from cell; R_3 from R_2 anastomosing with R_4 to form areole; M_1 from upper angle of cell; cell open apically between M_1 and M_2 ; M_2 and Cu_1 from near angle of cell. Secondaries faintly or predominantly bicolor; SC anastomosing with cell near base; R and M_1 stalked; M_2 obsolescent from just below middle of discocellulars; M_1 and Cu_1 from angle of cell. Abdomen dark brown to black with large brown dorsal tufts on segments 2 and 3; long white-tipped black or brown hairs terminally. Greatest length of forewing 12-14mm.

DISCUSSION

Until the description of *bicolor* McDunnough (1941), *Behrensia* was a monotypic genus with *conchiformis* Grote designated

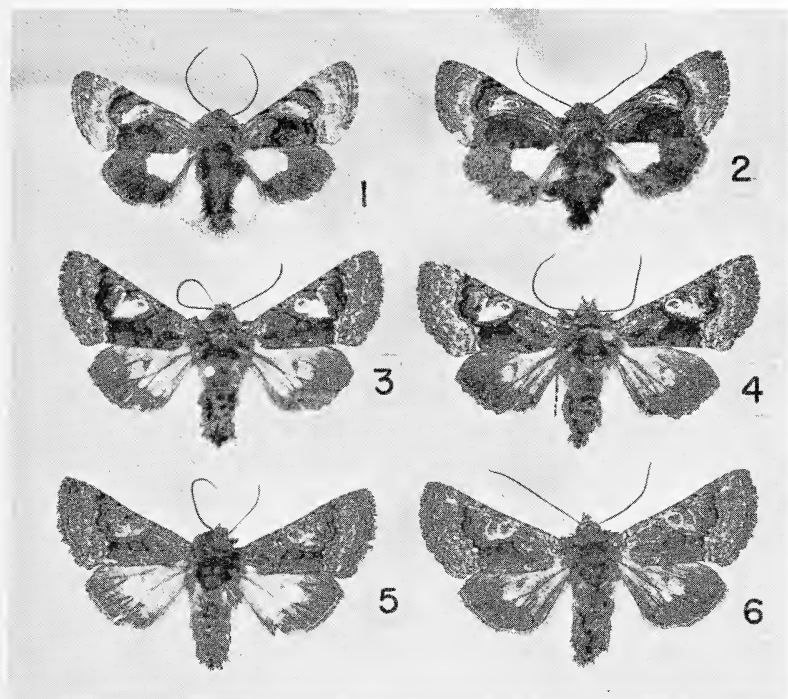


Fig. 1. Male, *Behrensia bicolor* McDunnough, Johnsville, Plumas County, California, June 10, 1962 (H. J. Pini).

Fig. 2. Female, *B. bicolor*, same locality as figure 1, May 18, 1962 (H. J. P.).

Fig. 3. Male, *B. conchiformis conchiformis* Grote, Anderson Springs, Lake County, California, March 5, 1960 (W. R. Bauer & J. S. Buckett).

Fig. 4. Female, *B. conchiformis conchiformis*, same locality as figure 3, March 16, 1960 (W. R. B. & J. S. B.).

Fig. 5. Paratype male, *B. conchiformis suffusa* Buckett, 2 miles S. E. Modjeska, Santa Ana Mountains, Orange County, California, March 2, 1963 (the Flemings).

Fig. 6. Paratype Female, *B. conchiformis suffusa*, Ojai, Ventura County, California, February 25, 1962 (W. E. Simonds).

as the type species by original designation. McDunnough places *Behrensia* near *Xylena* Ochsenheimer, from which it differs superficially by its much smaller size, blacker coloration, less elongated wings, and the presence of abdominal tufting. The smallest North American *Xylena* exhibits a forewing expanse of no less than 20mm. The greatest expanse exhibited by either *Behrensia* species is 14mm.

Behrensia apparently is not closely related to *Xylena* superficially or genitally. In the male genitalia, the short, blunt digitus, as well as the lack in other modifications of the valve, seem to remove *Behrensia* from its present placement. It seems more logical to place *Behrensia* near *Oncocnemis* Lederer as indicated by various internal structures as the internal tympanum. The only obvious factor relating *Behrensia* to *Xylena*, *Xylotype* Hampson or any of this section of the Cucullinae is the wing venation. (It may be noted that the wing venation of *Behrensia* is also very similar to that of *Syngrapha* Hbn., with the exception of the adjunction of R_4 to R_3 . The genitalic structures of both sexes are symbolic of some *Plusiinae*.)

The presence of a corona on the valve of the male genitalia is apparently a constant characteristic of the Cucullinae until *Behrensia* is considered. At best, it has a very weak suggestion of a corona. The absence of a corona combined with additional external characteristics has been definitive of *Plusiinae*. *Behrensia* lacks the well-developed digitus of the male genitalia, and it does not turn down obliquely across the valve before the cucullus. *Behrensia* is placed in the Lithophanini if one if to correlate the information published to date.

The deciding factor placing *Behrensia* very nearly where it is now placed is the larva. With one species of larvae at hand and the accompanying notes on larval habits, one can see relationships between *Behrensia* and *Pleroma* Smith.

Until a much more thorough study can be made of *Behrensia* in relationship to other genera in the Cucullinae, there may be disagreement as to its placement.

Superficial Key to Adults

1. Secondaries very distinctly bicolor, as in figures 1 and 2.....*bicolor* McD.
Secondaries indistinctly bicolor; primaries with scattered gold and green scales 2
2. Primaries with median area black, distinctly contrasting with sub-terminal and terminal areas; orbicular and reniform pure white; white scales present in both subterminal and terminal areas*conchiformis conchiformis* Grote
Primaries suffused with smokey gray scales, median area not as above; orbicular and reniform suffused with smokey gray scales; subterminal and terminal areas both lacking white scales.
.....*conchiformis suffusa* Buckett, n. ssp.

Key by male genitalia

1. Valve less than 2.5 mm long; aedeagus .50mm at narrowest width, less than 2.5 mm long; vessica with single large spine as in figure 12*bicolor* McD.

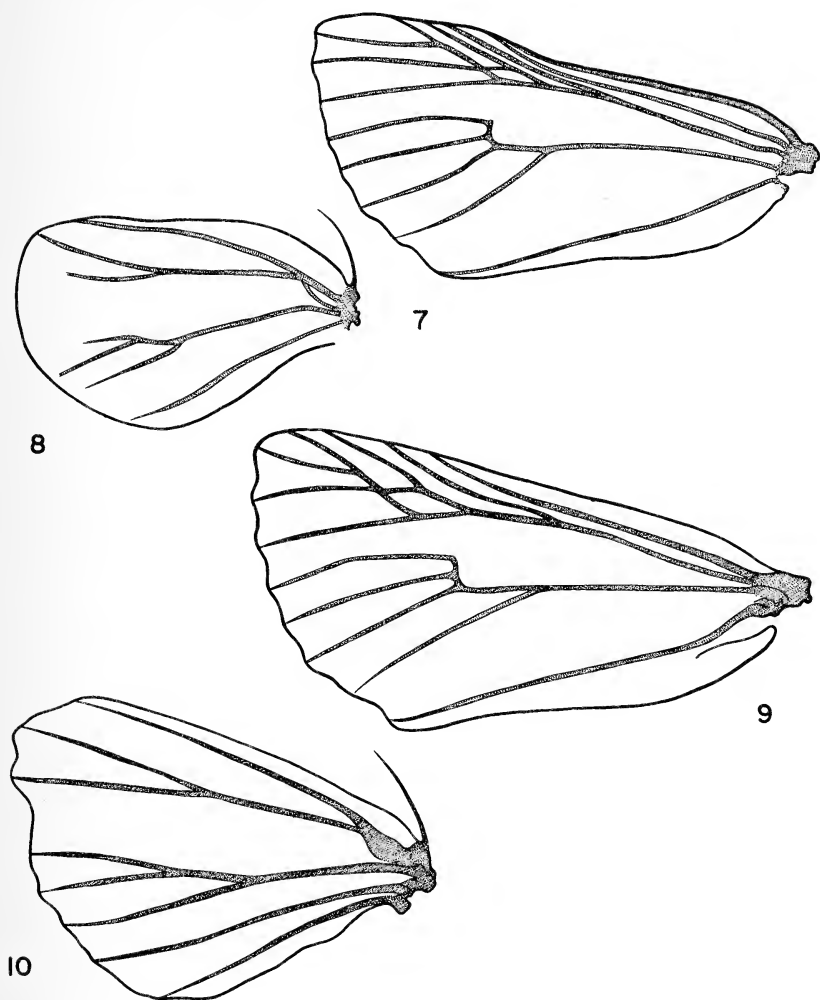


Fig. 7. Wing venation of right primary, *B. bicolor* (Bauer-Buckett slide No. 63C26-21), Johnsville, Plumas County, California, June 7, 1962 (H. J. P.).

Fig. 8. Wing venation of right secondary, *B. bicolor*, same data as figure 7.

Fig. 9. Wing venation of right primary, *B. conchiformis conchiformis* (Bauer-Buckett slide No. 63C26-22), Inverness, Marin County, California, March 10, 1959 (W. R. B. & J. S. B.).

Fig. 10. Wing venation of right secondary, *B. conchiformis conchiformis*, same data as figure 9.

- Valve greater than 3.0 mm long; aedeagus .75 mm or greater at narrowest width, greater than 3.0 mm in length; vesica with more than one large spine 2
2. Ampulae of valve large (valves small in comparison with ampulae); armature of vesica in aedeagus heavily sclerotized as in figure 14 *conchiformis conchiformis* Grote
- Ampulae of valves smaller; valves larger in comparison to ampulae; vesica not extremely heavily sclerotized, as in figure 15. *conchiformis suffusa* Buckett, n. ssp.

Key by female genitalia

1. Lamella postvaginalis of genital plate simple *bicolor* McD.
Lamella postvaginalis developed into a huge fork, as in figure 17 2
2. Genital plate lightly sclerotized; lamella postvaginalis not widely forked; ovipositor lobes rounded *conchiformis suffusa* Buckett, n. ssp.
Genital plate lightly sclerotized, lamella postvaginalis widely forked; ovipositor lobes pointed *conchiformis conchiformis* Grote

***Behrensia conchiformis conchiformis* Grote**

Behrensia conchiformis Grote, 1875. Canadian Ent. 7:71. Smith, 1893, p. 246; Dyar, 1902, p. 203; Holland, 1903, Moth Book, p. 241, pl. 28, fig. 44; Hampson, 1906, vol. 6, p. 287, fig. 83; Barnes & McDunnough, 1917, p. 59; Draudt in Seitz, 1923, vol. 7, p. 197, pl. 28, fig. 13; Blackmore, 1927, p. 24; McDunnough, 1938, p. 84.

HEAD with antennae moniliform, lengthily setose, terminal setae becoming longer; two lateral single rows of gray scales for entire antennal length; palps with loosely spaced, black simple hairs, a row of contrasting black scales exterolaterally; third segment less than one half the length of second segment; frons covered with brown-tipped scales shading into white-tipped scales at vertex; proboscis normal, setae evident along basal portion. THORAX ash colored with collar of coppery brown elongated scales, porrect, giving head appearance of being sunken; tegulae black anteriorly, posteriorly white-tipped; basal tuft of coppery brown spatulate scales; all tibiae unspined, mid tibiae with one pair of end spurs, hind tibiae with two pair of spurs; tarsi black and white banded. Primaries with deep gray ground color, median area black; basal line hardly discernible; basal area with scattering of green-golden scales; transverse anterior line geminate, distally black; clariform outlined in black; orbicular white outlined, centrally filled with ground color, confluent with reniform; reniform basally white fading into ground color distally; transverse posterior line geminate, light brown band formed between geminations; tornus area with scattering of green-golden scales; golden scales present between R_2 and R_3

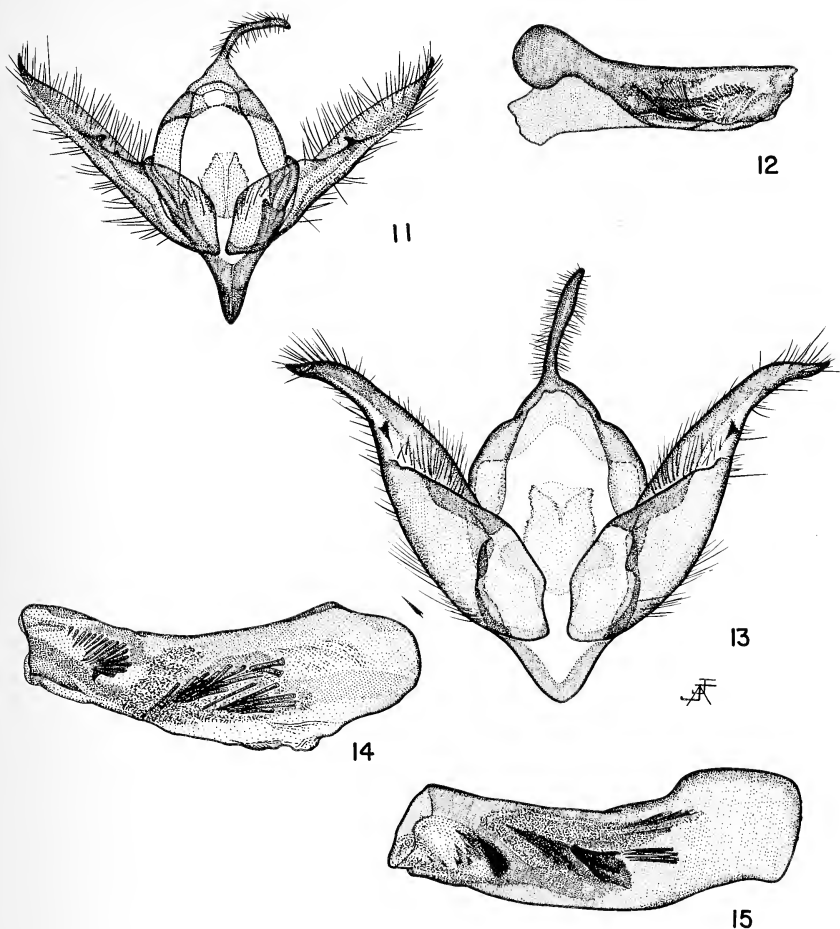


Fig. 11. Male genitalia minus aedeagus, *B. bicolor* (Bauer-Buckett slide No. 63C23-21) Johnsville, Plumas County, California, June 7, 1962 (H. J. P.).

Fig. 12. Aedeagus of *B. bicolor*, same data as figure 11.

Fig. 13. Male genitalia minus aedeagus, *B. conchiformis conchiformis* (Bauer-Buckett slide No. 63C23-26) Anderson Springs, Lake County, California, March 16, 1960 (W. R. B. & J. S. B.).

Fig. 14. Aedeagus of *B. conchiformis conchiformis*, same data as figure 13.

Fig. 15. Aedeagus of *B. conchiformis suffusa* (Bauer-Buckett slide No. 63C23-25) Ojai, Ventura County, California, February 25, 1963 (W. E. Simonds).

in subterminal area; subterminal and terminal areas both slightly lighter than ground color; subterminal line indicated by a band of white scales; terminal line indicated by dark lunules between veins; fringes deep gray. Ventral surface of primaries with ground color deep gray; median area whitish; transverse posterior line indicated in black. Secondaries basally whitish, irrorated with brown scales; discal mark distinct, black; apical band broad, deep fuscous; fringes white. Ventral surface very similar to dorsal surface except on costal margin where there is a predominance of black scales irrorated evenly over the whitish area. Abdomen blackish; first abdominal segment with large, centrally concave tuft composed of brown scales all of which appear to have arisen centrally; second abdominal segment with a smaller more regular tuft. Expanse of primary 13 mm. Genitalia as in figures 13 and 14.

Female: As in male except whitish basal area may be more suffused with brown fuscous scales. Greatest length of forewing 14 mm. Genitalia as in figure 17. Type locality: Sausalito, Marin County, California. Location of type: British Museum of Natural History.

Specimens examined: 5 males 10 females, Anderson Springs, Lake County, California, March 5-15, 1960 (W. R. Bauer & J. S. Buckett); 2 females, Anderson Springs, Lake County, California, March 22, 1949 (W. R. B.); 1 female, Anderson Springs, Lake County, California, April 16, 1950 (W. R. B.); 1 female, Cobb Mountain, Lake County, California, February 10, 1955 (W. R. B. and J. S. B.); 1 male, Cobb Mountain, Lake County, California, December 27, 1956 (W. R. B. and J. S. B.); 1 female, Angwin, Napa County, California, February 12, 1949 (D. L. Bauer); 5 males, 14 females, Mill Valley, Marin County, California, March 12, 1920 (E. P. Van Duzee); 1 female, Mill Valley, Marin County, California, April 6, 1950 (F. X. Williams); 1 female, Inverness, Marin County, California, March 30, 1950 (H. P. Chandler); 3 females, Inverness, Marin County, California, March 13-14, 1959 (W. R. B. and J. S. B.); 1 male, Inverness, Marin County, California, March 8, 1955 (J. S. B.); 2 females, Petaluma, Sonoma County, California, March 3, 25, 1938 (W. R. B.); 1 male, Berkeley, Alameda County, California, March 8, 1923 (J. E. Law); 1 male, 1 mile north of Elephant Butte, Plumas County, California, April 5, 1960 (W. R. B. and J. S. B.); 4 males, 1 female, 5 miles northwest of Corvallis, Benton County, Oregon, April 1, 1962 (A. N. McFarland); 2 females, 5 miles northwest of Corvallis, Benton County, Oregon, March 1, 1963 (A. N. McFarland); 1 male, McMinnville, Yamhill County, Oregon, April 4, 1953 (K. M. Fender); 2 males, 5 miles northwest of Corvallis, Benton County, Oregon, April 2, 1962 (A. N. McFarland); 1 female, Quamichan District, Vancouver Island, British Columbia, April 14, 1920 (A. W. Hanham).

DISCUSSION

This species is taken in fair numbers, but can hardly be considered overly abundant as are many of our more common species. *B. conchiformis* in California is collected primarily in

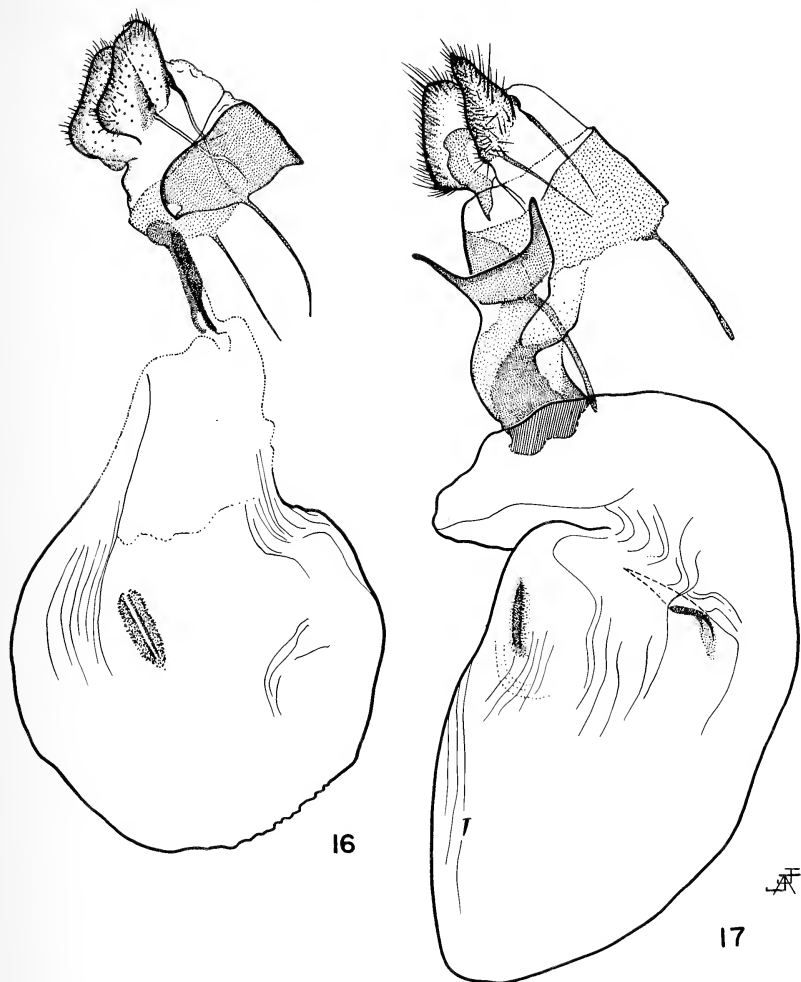


Fig. 16. Female genitalia of *B. bicolor* (Bauer-Buckett slide No. 63C23-22) Johnsville, Plumas County, California, May 28, 1962 (H. J. P.).

Fig. 17. Female genitalia of *B. conchiformis conchiformis*, (Bauer-Buckett slide No. 63C23-27) Anderson Springs, Lake County, California, March 16, 1960 (W. R. B. & J. S. B.).

the spring but is also recorded in the winter months. It is found from the humid coastal area (Inverness, Marin County, California) into the Sierra Nevada (Quincy, Plumas County, California) and from Marin County, California, northward into British Columbia, Canada (Teste Blackmore, 1927). One of its known food plants, Snowberry, *Symphoricarpos albus* (= *rivu-*

laris of Munz), is rather widely distributed, occurring from Monterey County, California, eastward into the Sierras and thence northward into Alaska. It seems probable that with further research concerning host plants, *conchiformis* may prove to be a more general feeder than it is presently known to be.

This species can be superficially distinguished from *bicolor* McDunnough by its scattered green scales on the primaries as well as by the lack of distinct, contrasting secondaries. It can be superficially distinguished from *conchiformis suffusa* Buckett, n. ssp. by its contrasting median area, white irrorated scales in both the subterminal and terminal areas, and pure white obicular and reniform of the primaries.

Larval description (5th instar): HEAD 1.9 mm broad, light pinkish with blue and brown pattern; 4.3 mm broad at abdominal segment 2 (larva preserved in KAAD and injected); abdominal segments proportionally as in figures 17-25; skin smooth; general color pinkish lilac; middorsal line light pink, margined by thin white lines, these thin white lines outwardly margined by broad lilac bands, 5 mm broad; lilac band bordered by light pink bands, 1.0 mm broad; supraspiracular band 0.5 mm broad, lilac; spiracles black bordered, yellow centered; infraspiracular thin white line margined by a lilac band, being 0.5 mm broad, intrasegmentally broadening to slightly greater than 1.0 mm on middle of segment; ventral surface of larva light pink at segments 2, 3, and 4 with conspicuous lilac splotch; prolegs laterally with pale lilac patches.

Chaetotaxy as in figures 23, 24 and 25 through 32. Mandible and terminal portion of proleg as in figures 21 and 22, respectively. Pupa as in figures 18, 19, and 20. Larva type No. 63C17-1 (N. 43 Noel McFarland), collected 5 miles northwest of Corvallis, Benton County, Oregon, April-May, 1962 (Noel McFarland). Deposited in the larval collection, Entomology Department, University of California, Davis, California.

Described from a single larva preserved in KAAD and injected. Food plant *Symphoricarpos albus*. From personal correspondence with Mr. McFarland, the author received information involving *Lonicera* sp. as a food plant for *conchiformis* in Southern California.

Mode of cocoon construction is the same as that seen in *Pleroma* spp. (teste McFarland) which is rather distinctive and peculiar. Larval behavior is reminiscent of *Pleroma* spp. as well.

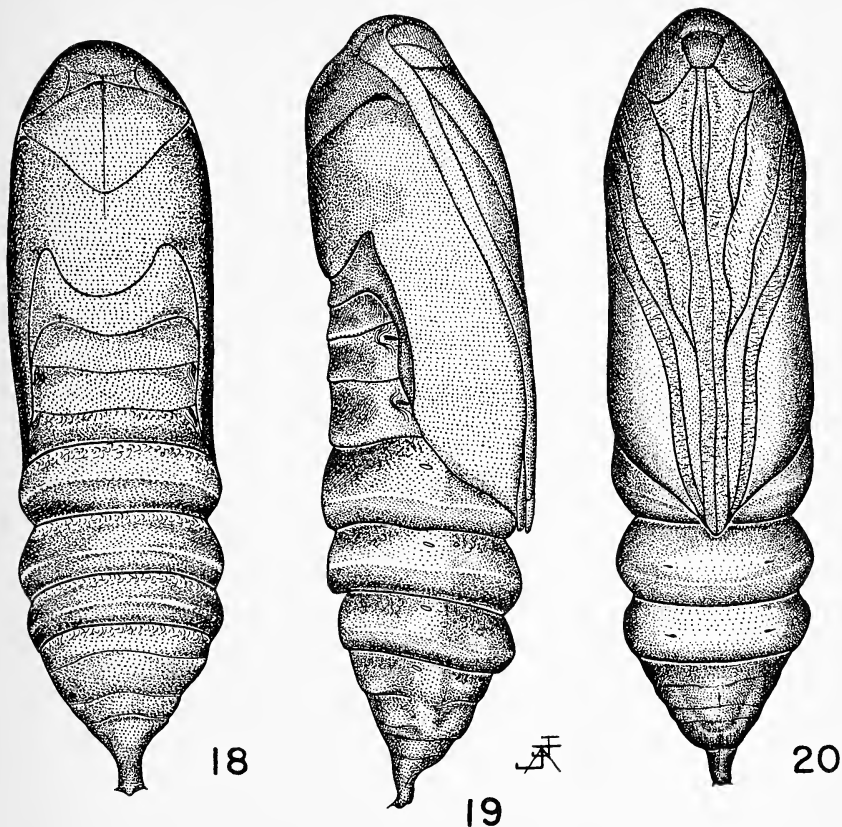


Fig. 18. Pupa of *B. conchiformis conchiformis*, dorsal view, 5 miles northwest Corvallis, Benton County, Oregon (A. N. McFarland).

Fig. 19, through 32 are all of *Behrensia conchiformis* with the same data as figure 18.

Fig. 19. Pupa, lateral aspect.

Fig. 20. Pupa, ventral aspect.

***Behrensia conchiformis suffusa* Buckett, new subspecies**

Male: HEAD as in nominate *conchiformis*. Thorax with collar dusky gray, rather than brown; primaries suffused with gray scales giving a dull appearance; median area suffused, gray; transverse anterior and transverse posterior lines outstanding; orbicular and reniform slightly suffused with gray scales; subterminal and terminal areas lacking white scaling, therefore

appearing dull gray. Secondaries dorsally, and both primaries and secondaries ventrally as in nominate *conchiformis*.

Male Genitalia: Slightly larger than nominate *conchiformis*, ampulae smaller, aedeagus with heavier sclerotized vesical armature, as in figure 15.

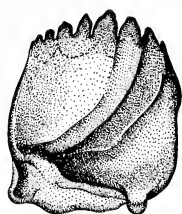
Female: As in male, except secondaries are more dorsally suffused. Female genitalia as in nominate *conchiformis* except genital plate more heavily sclerotized.

Holotype male, Vincent, Mint Canyon, Los Angeles County, California, February 11, 1950 (C. A. Hill).

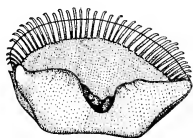
Paratypes: One female, same data as Holotype (designated Allotype); 2 males, 2 females, Verdugo Woodlands, Glendale, Los Angeles County, California, February 17, 1950 (C. A. Hill); 3 females, Glendale, Los Angeles County, California, March 9, 1927; 1 female, Glendale, Los Angeles County, California, April 4, 1928; 2 males, Glendale, Los Angeles County, California, May 4, 1928; 1 female, Glendale, Los Angeles County, California, August (?) 17, 1928; 1 female, Glendale, Los Angeles County, California, January 1, 1928 (E. D. Jones); 1 male, 2 females, Singing Springs, San Gabriel Mountains, Los Angeles County, California, March 18, 1949 (C. A. Hill); 2 males, 2 females, Upland, San Bernardino County, California, March 24, 1957, March 5, 1959, April 2, 1959, December 17, 1957, respectively (T. M. Blackman); 2 males, Calabasas, Los Angeles County, California, October 4, 1928; 1 male, Calabasas, Los Angeles County, California, September 29, 1927; 2 males, San Diego, San Diego County, California, December 26, December 29, 1919 (K. B. Coolidge); 1 male, San Diego, San Diego County, California, March 12, 1924; 1 male, 1 female, San Diego, San Diego County, California, December 26, 1919 (E. Piazza); 1 male, San Diego, San Diego County, California, December 25, 1927; 2 females, San Diego, San Diego County, California, January 2, 1919; 1 female, near Acton, Mint Canyon, Los Angeles County, California, May 5, 1952 (C. A. Hill); 1 male, Pearlblossom, Mojave Desert, Los Angeles County, California, May 3, 1952 (C. A. Hill); 1 female, La Crescenta, Los Angeles County, California, April 3, 1954 (W. A. Rees); 1 female, Atascadero, San Luis Obispo County, California, March 30, 1922 (V. L. Claercker); 1 male, 5 miles north of Beverly Hills, Benedict Canyon, Santa Monica Mountains, Los Angeles County, California, March 16, 1956 (A. N. McFarland); 3 females, Ojai, Ventura County, California, February 25, 1962 (W. E. Simonds); 1 male, Singing Springs, Angeles Forest, Los Angeles County, California, March 13, 1950 (C. A. Hill); 2 males, 1 female, 2 miles southeast Modjeska, Santa Ana Mountains, Orange County, California, March 2, 1963 (the Flemings). Additional specimens: 2 females no data; 2 males, 1 female, Denver, Denver County, Colorado, July 19, 1917; 1 female, Denver Denver County, Colorado, May 5, 1916.

DISCUSSION

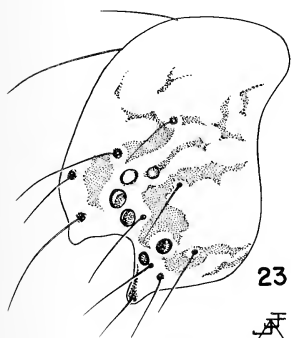
This subspecies can be readily distinguished from nominate *conchiformis* by the suffusion of the primaries, dull white coloration of orbicular and reniform, and lack of white scalation of thoracic vestiture. Genitally it differs in the male by the smaller ampulae, and less heavily sclerotized vesical armature of the aedeagus. In the female genitalia, the lighter sclerotization of the genital plate will suffice as a diagnostic characteristic.



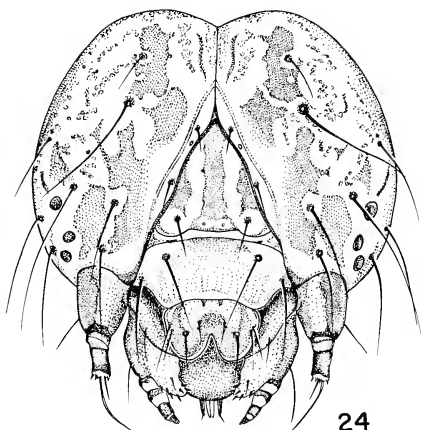
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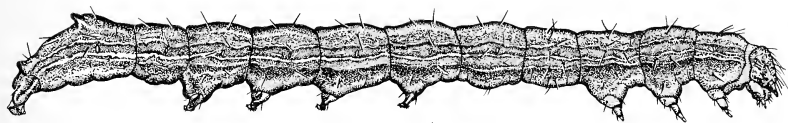
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Fig. 21. Mandible, mesal aspect.

Fig. 22. Crochet of proleg.

Fig. 23. Lateral view of head, minus appendages.

Fig. 24. Cephalic view of head.

Fig. 25. Lateral view of fifth instar larva.

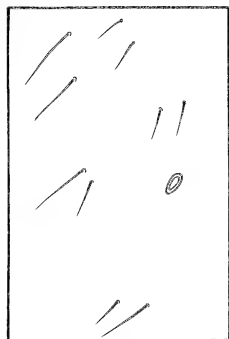
This subspecies is found over the mountainous regions of southern California as well as along the coast to San Diego. It also occurs on the edge of the Mojave Desert. The Colorado specimens exhibit suffusion of the dorsal surface of the primaries and are believed to be *suffusa*; however, they are excluded from the paratypical series because of the great separation in locality.

The holotype and 28 paratypes are deposited in the Los Angeles County Museum; 11 paratypes and 1 paratype designated allotype are deposited in the Bauer-Buckett collection, Davis; two paratypes are deposited in the Entomology Collection, University of California, Davis; two paratypes are deposited in the California Academy of Sciences, San Francisco, California; and one paratype is deposited in the J. G. Franclemont collection, Cornell University, Ithaca, New York.

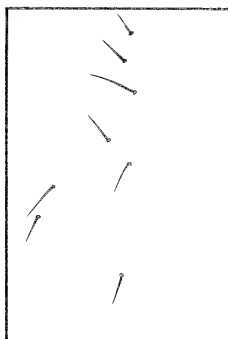
***Behrensia bicolor* McDunnough**

Behrensia bicolor McDunnough, 1941. Canadian Ent. 73:68.

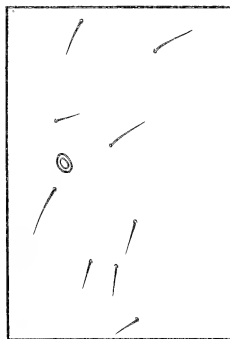
Female: Antennae moniliform, very fine setae along length terminally becoming longer, two lateral rows of gray-white scales for entire antennal length; palps clothed in admixture of brown and black scales and hairs, giving a dark appearance, third segment less than one half length of second; frons clothed with brown scales, scales extending to vertex; eyes round, smaller than those of *conchiformis* Grt. Thorax with collar porrect, separate, protruding forward, composed of brown and white spatulate hairs; remaining dorsum of thorax with white-tipped, coal black spatulate scales becoming intermixed with elongate black hairs and tufting of brown spatulate scales posteriorly; venter of thorax clothed in deep brown vestiture except for a few flattened, white-tipped hairs at wing base; legs clothed in deep brown, white-tipped elongate hairs; all tibiae unspined, mid tibiae with one pair of spurs; tarsal segments with thin white apical band. Primaries dorsally with basal line obscured, a thin black basal dash evident in central portion of the dark grayish basal area as well as a scattering of fawn brown scales; transverse anterior line black, geminate, forming an "S" between costa and inner margin; medial area deep brown; claviform elongate, deep black, hardly discernible from deep brown medial area; median area ventrad and dorsad of orbicular with ground color dark grayish; orbicular white outlined, filled with brown scales, a white dash appearing from base to transverse posterior line on M_3 ; reniform obscure, black outlined, separate from black transverse posterior line; distally of transverse posterior line a thin brown band from costa culminating in a fawn brown dot between M_3 and Cu_1 , then on to inner margin; subterminal and terminal areas gray, washed or irrorated with white scales; subterminal line a zig-zagged series of smokey shadings not clearly defined; terminal line continuous, only appearing broken when fringes are damaged; fringes brownish gray. Ventral surface of



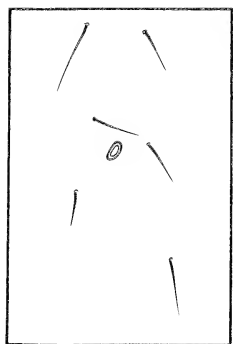
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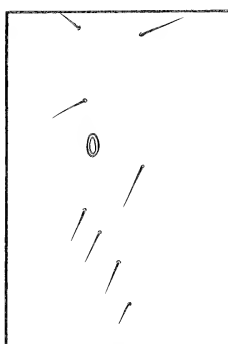
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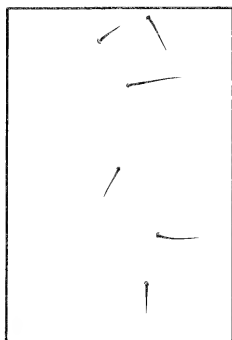
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Fig. 26, through 32 are all setal maps.

Fig. 26. Thoracic segment No. 1.

Fig. 27. Thoracic segment No. 2.

Fig. 28. Abdominal segment No. 1.

Fig. 29. Abdominal segment No. 3.

Fig. 30. Abdominal segment No. 7.

Fig. 31. Abdominal segment No. 8.

Fig. 32. Abdominal segment No. 9.

primaries smokey brown with hairbrush of white-tipped hairs, central portion with white patch. Secondaries quite diagnostic, bicolor, white on basal half, deep brown for apical half; fringes whitish tipped at anal angle becoming concolorous deep brown toward costa. Ventral surface of secondaries as in dorsal surface except in white half of wing where costal portion is irrorated with deep brown scales. Abdomen with dorsum of very deep brown hairs; two huge fawn brown tufts present, one on segment 3 and the other on segment 4; ventral surface of dark brown hairs, posteriorly of white-tipped deep brown hairs. Genitalia as in figure 16. Greatest length of forewing 12 mm.

Male: As in female, also retinaculum whitish; greatest length of forewing 13 mm. Genitalia as in figures 11 and 12.

DISCUSSION

This little known species has been collected more frequently in the past three years, a series of over 40 specimens having been collected. Until recently, *bicolor* was known only from the holotype, two paratypes, and one additional specimen. This increase in number of collected specimens is probably due to the use of the 15 watt fluorescent black light in place of regular incandescent white light and continuous combined with more extensive collecting.

From data of the past three years, it is also interesting to observe that the range of *bicolor* has been considerably extended, its previously known range being only a short 5 mile extension from the type locality. There are now three counties represented, including Nevada, Plumas, Shasta counties, of California.

This species can superficially be distinguished from *conchiformis conchiformis* Grt. and *conchiformis suffusa* Buckett by its contrastingly bicolor secondaries, and genitally by the lack of the huge prominent "Y" shaped antivaginalis of the genital plate in the female.

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LARVAL HABITS OF *AGATHYMUS MARIAE* (B. & B.)

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ALTHOUGH THE LIFE HISTORY of *Agathymus mariae* (B.&B.) has been known for a number of years many of the details concerning it have remained unpublished. It is an established fact that the larvae have been found only in *Agave lechuguilla* Torr. and there is some apparent reason why this occurs. Several times larvae from *lechuguilla* have been transplanted to other species of *Agave* with rather poor results. During November 1959 larvae were brought home and placed on three species of *Agave* that I had growing for this purpose. One was typical *lechuguilla* from west Texas, one was *Agave scabra* Lam-Dyck from the Big Bend National Park and the last was *Agave neomexicana* Wood & Standley from the Davis Mts., Texas

One larva was placed near the base of a leaf of *lechuguilla*, Nov. 29, 1959 at 11:30 A.M., at 12:30 no apparent effort to enter the leaf had been made even though a small hole had been made in the leaf with a nail near where the larva had been placed. On Nov. 30 the larva made its way into the hole in the leaf and after two days some frass was deposited outside the hole in the leaf. This larva remained throughout the winter in the plant and completed its cycle in October the following year, emerging a male, Oct. 7, 1960.

One larvae was placed near a similar hole made in a leaf of *scabra* on the same day and at approximately the same time. This time the larva moved around the hole and within fifteen minutes had crawled into it. After two days there was no visible signs of frass present. In two weeks the spot where the larva had entered the leaf began turning brown. This continued for three weeks after which the entire leaf, which was much larger than the *lechuguilla* leaf, died. One larva was placed on a leaf of *neomexicana* at the approximate same time as the other two. The leaf had been prepared as in the two preceding plants. The larva entered the hole in the leaf after crawling around for

¹ I am deeply indebted to the National Science Foundation for Research Grants G-9900 and GB-398 making my work on the Megathymidae possible.

about twenty minutes. On Dec. 6, the larva was no longer visible by looking into the hole as it had penetrated about two inches farther basad in the leaf. On this day the hole where the larva entered began turning brown and by Dec. 25 the entire leaf was dead. Apparently the larva was causing sufficient injury to the leaf to produce these results or else it was secreting some material which was toxic to that particular species of plant. This most likely has resulted in the extreme selectivity of the female *mariae* in placing their eggs around or in *lechuguilla* plants.

The manner in which the larvae of *mariae* construct their trap door over their feeding tunnel in the leaf is very interesting. One of the characteristics of *mariae* is to extend its tunnel through two or three leaves but usually not going into the caudex to any extent and then to construct its serecin-like trap door over the opening to the outside two or three weeks prior to pupation. Several plants in which larvae of *mariae* were present were collected August 8, 1960, four to five miles west of Victoria Canyon, Cuthbertson Co., Texas. Some of the larvae had already made their trap doors while others were still in a period of quiescence. On August 10, observations were made concerning the method they used in constructing their doors. At 9:05 A.M. the larva under observation started making a round hole at the spot where it had previously defecated. It worked at this hole for an hour and five minutes. At 10:10 it went down into its tunnel and came up in two minutes and five seconds with white powder all over its head and then it started rubbing this powder all over the hole that it had made. It would do this for from two to five minutes and then go back into its tunnel to reappear again in about two minutes with a fresh supply of white powder. The powder glands are located near the caudal end of the larva. These glands would leave a large supply of powder about two inches down in the tunnel. The larva would back down beneath this area and rub its head back and forth thus collecting a lump of powder on the vertex of its head. At 11:05 it stopped making the trips down into the tunnel and started constructing the door. This was accomplished by the larva making circular movements with its head as it exuded a silken material from its mouth. The material was snow white and as the door was formed, it also was of the same color. The larva was making the door on the upper side of the leaf, which is a characteristic of *mariae*. It made the upper part first so that the door had the appearance of an upside down crescent. The

door was transparent at first but as the material dried and hardened, it became opaque. At 11:25 the door was completed except for an area near the bottom just the size of the larva's head. Then the larva started working on the lower side. At 11:35 the lower part had been completed, leaving only a tiny hole about two-thirds of the way down from the center of the door. The door was completely formed at 11:46, but the larva continued to work on the middle portion until 12:01 when it retreated back into the tunnel to start another period of quiescence prior to its pupation. The entire time involved was two hours and fifty-six minutes. Seven days later the door had changed color to the characteristic tan of this species.

On August 22, 1960 the procedure of pupation employed by *mariae* was recorded. The larva observed was one collected August 8, 1960, four to five miles west of Victoria Canyon, Texas. This specimen was very quiet for approximately twenty-four hours prior to this time. At 9:10 P.M. it started gradual movements from the caudal end cephalically. After ten minutes of this it gave four or five rather violent jerks and the skin began to separate down the anterior, midline of the thoracic region and then gradually down the midline of the head. At 9:20 the pupa began to work itself out of the larval skin by slow and gradual movements beginning at the caudal end, progressing anteriorly. The pupa was of dark green color as it made its appearance. When the pupa was about one half of the way out of the larval skin, it started a lateral movement of the abdomen, speeding up the shedding process. When the skin was two-thirds off and was confined to the last four abdominal segments, the pupa started gradual movements from the caudal end anteriorly, not moving the thoracic region at all. All action took place with the larva and then the pupa on its back. At 10:35 the larval skin was still attached to the last two segments but by rather vigorous lateral movements at 11:03 the larval skin was finally freed from the pupa. The entire process required one hour and fifty-three minutes. Twenty-four hours later the color of the pupa was light brown.

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INSTAR DETERMINATION OF AGATHYMUS LARVAE

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TO DETERMINE THE NUMBER of instars or a specific instar can be difficult, particularly when ecdysis is not readily observed as is the case with *Agathymus* larvae. An attempt to solve the problem of instar determination of *Agathymus* larvae was made through the application of Dyar's "law". Dyar (1890) made two generalizations: the sclerotized parts of larvae do not change in area during an instar, the increase in these parts during larval development occurring only at ecdysis; the discontinuous increase in the dimensions of sclerotized parts during larval development usually takes the form of a geometrical progression (Dyar's law). It would therefore follow that instars can be characterized by the measurements of sclerotized areas of any individual if the range of variation for each instar is known and does not overlap the dimensions of other instars. Also, if measurements can be made of two successive instars of an individual a geometrical progression could be found which would be useful in predicting the measurements to be expected of the other instars.

To test these hypotheses measurements were made of larvae from several *Agathymus* populations (Table 1). I selected the width of the head capsule at the widest point as the sclerotized part to measure. This was done under a dissecting microscope containing ocular grids calibrated with a stage micrometer. All measurements were rounded to the nearest 1/50 mm in the case of the first and second instars; to the nearest 1/10 mm for the remaining instars. The larvae were killed and fixed for a period not exceeding 30 minutes in a modification of Peterson's K.A.A.D. mixture (Atkins, 1958), then stored in 95% ethyl alcohol. The only measurements discarded were of those larvae which had recently moulted as shown by soft, untanned sclerotized areas. Larval fixation caused distortion to those unhardened areas.

The graphs (Fig. 1) show the measurements obtained

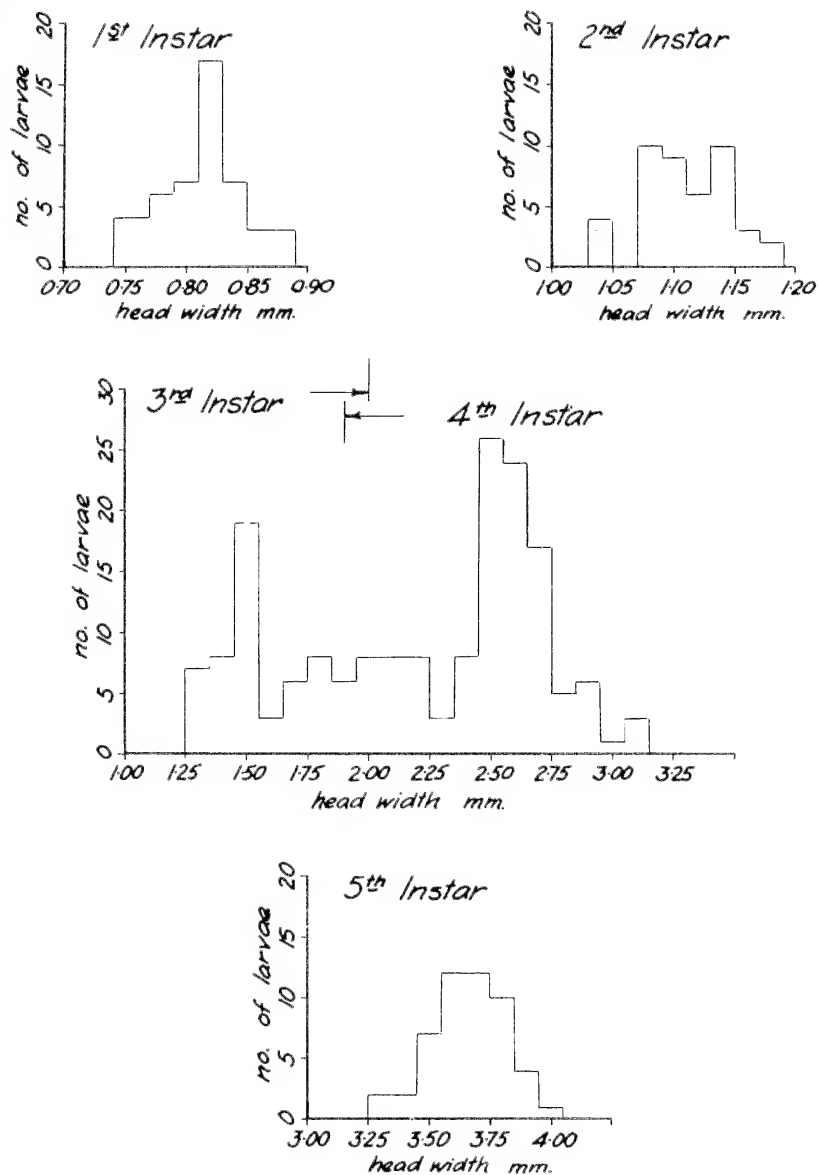


Figure 1. Histograms illustrating head width variation of *Agathymus* larvae at various instars

from an *Agathymus aryxna* population in the Santa Catalina Mountains which was sampled bi-monthly from November until June. The distribution curves for the first, second, and fifth instar larvae are clear-cut because they do not overlap the measurements of the other instars. The distribution curves of the third and fourth instars do overlap. This overlap was substantiated by a comparison between fourth instar larvae which had recently moulted and the head capsules of the preceding instar which remained in the burrows. A similar overlap was detected in smaller samples of *Agathymus polingi* and *A. baueri*. The possibility exists that a variation in the number of instars may occur in a given population, a condition which has been demonstrated to occur in some Lepidoptera.

Instar determination within the range of overlap can not be made solely on the basis of head width measurements. Furthermore, the progressions derived from the measurements of successive instars are not satisfactory in predicting the approximate head width of the other instars.

The comparison of the larvae of *A. aryxna*, *A. baueri*, *A. polingi*, and *A. neumoegei* in all instars provided a combination of characters which generally proved successful for instar determination without establishing the range of variation in the sclerotized areas of the larvae in each population. A key to the instars is as follows:

- | | |
|---|---------------|
| 1. Parietals dark brown or black; concolorous | 2. |
| 1'. Parietals uniformly light or patterned with dark brown markings on a light background | 4. |
| 2. Only primary setae present; setae few in number and and borne on conspicuous tubercles | First Instar |
| 2'. Secondary as well as primary setae present | 3. |
| 3. Primary setae clearly longer than the secondary setae | Second Instar |
| 3'. Primary setae not readily distinguishable in length from the secondary setae; all setae short | Third Instar |
| 4. Parietals not concolorous; pattern of dark brown markings on a light brown background | Fourth Instar |
| 4'. Parietals concolorous; light brown | Fifth Instar |

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THE EARLY STAGES OF *EUPHYES VESTRIS*

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RANGING ACROSS THE UNITED STATES and southern Canada *Euphyes vestris* (Boisduval) is a common species of fields and waste areas. An avid flower visitor, it is especially attracted to *Mentha*, *Apocynum* and *Asclepias* species. Males are occasionally found clustered at damp spots along creek beds, roadsides and lake shores. Most references describe *vestris* as having only one brood but I have found it to be double brooded at least as far north as southern Iowa. In Northern Michigan a single brood occurs about the first of July. In Missouri where it is double brooded the first brood emerges during the third or fourth week of May and flies into early July. The second brood occurs from about the end of July to late September. In Missouri hibernation is effected by the third instar larvae of the second brood. Although it is a very common insect there has been almost a complete lack of published information concerning the early stages of this skipper. In May, 1963, I decided to rear a series and collected several females for this purpose. Since the host plant was unknown I took several flower pots and planted different species of grasses in each pot. These were covered with nylon netting and a female was placed in each bag with suitable flowers. In every instance I failed to get a single egg although the females lived as long as seven days. After repeated failures with other females and different plants I dissected the abdomens of two worn females and removed the eggs. I might add at this point that I have used this method before in extreme cases with Hesperiidæ and *Papilio* species. One or two fertile ova can usually be obtained by using this procedure. In this case two fertile ova were secured and the larvae emerged seven days later. Again many grass species were offered but the larvae only wandered aimlessly about refusing to eat. I finally tried a small sedge, *Cyperus esculentus* L., that grows as a weed along

roads and ditches in rather damp locations. The larvae fell upon this with relish and were easily reared. Second brood females layed eggs freely when confined with this sedge so it seems certain that this is one of the normal host plants in this area. The following description applies to the eastern subspecies *Euphyes vestris metacomet* Harris.

OVA: When first layed the egg is pale green, unmarked and hemispherical in shape. On the second day fertile ova develop an irregular red spot on the apex and an irregular red band circling the egg about midway between apex and base. Eggs are laid singly about midway up a leaf, usually on the underside and near an edge.

FIRST INSTAR LARVA: The emerging larva eats about one half of the eggshell. The general body color is yellow with segments 8, 9 and 10 pale yellow. The entire body is covered with short white hair. There are a few longer hairs visible on the last abdominal segment. Head pale shiny brown, mandibles black. The prothoracic shield is jet black.

SECOND INSTAR LARVA: Body pale green with a white overcast and covered with minute black setae. The prothoracic shield is black and there is a large black dot at the first spiracle. The head is pale orange with dark brown mandibles and an oblong dark brown spot set vertically in the upper center of the face.

THIRD INSTAR LARVA: Body pale watery green, last abdominal segment covered with white hairs and grayish green in color. The prothorax is white with a shiny black prothoracic shield. Head pale orange brown with three pair of cream colored vertical stripes. One pair following the outer edges of the epicranial plates, another pair starting at the base of the jaws and angling to the crown. The final pair run parallel to the vertical stalk of the epicranial suture. There is a deep brown oval spot in the center of the face near the crown and the entire head is covered with minute yellow bristles.

FOURTH INSTAR LARVA: Body bright translucent green with many narrow white horizontal dashes. The prothoracic shield is white dorsally with a narrow black line at the sides extending to the first spiracle which is marked with a large black dot, other spiracles unmarked. Head caramel brown with a pale cream colored band running from the outer edge of the jaws to the crown. There is a large black oval spot set vertically in the upper center of the face. There are two narrow cream colored bands parallel to and extending just below the black oval spot. In this instar a tent about four inches long is formed of three sedge leaves sealed together. The larvae in this instar are sluggish and play dead when handled.

FINAL INSTAR LARVA: Body pale translucent green with a white overcast caused by multiple horizontal wavy white dashes that cover the body. There are a few hardly noticeable white hairs sprinkled over the body. Each spiracle is indicated with a black dot, a larger dot at the first and anal spiracles. The prothorax is white with the prothoracic shield indicated by a thin black line running into the enlarged first spiracle dot. The back of the head is black, the rest of the head is caramel brown with two cream colored bands. One starting at the crown and running down the outer edges of the epicranial plates to the back of the jaws. The other band edges the black area at the back of the head. It is very narrow at the crown, becoming wider at the base. There is a velvet black oval spot set vertically in the upper center of the face, circled with a narrow cream colored line but not crossing the epicranial suture above or below the black oval spot. The sides of the mandibles are edged with cream and the jaws are deep brownish black. The larvae are very quiet in this instar and when touched curl slightly and remain still for many minutes before moving again.

PUPA: Abdomen pale whitish green, wing cases and thorax pale yellow green, wing cases slightly yellower. The yellow green of thorax and wing cases blends into a pale brown at the head and eye cases. The spiracles are dark brown. There is a slight whitish dusting, especially on the abdomen. The head is covered with short reddish bristles and the abdominal segments are spotted with short red bristles, especially noticeable on the final three segments. The cremaster is a slightly raised brown ridge with two very small dark brown points at each side. These points are slightly offset dorsally. The pupa is slightly translucent and appears rather blotchy in places because of this. The tongue case is quite long, extending to the fourth abdominal segment, detached at upper edge of second abdominal segment. Length of pupa, 18 -19 mm. Width at widest point of wing cases, 4 mm.

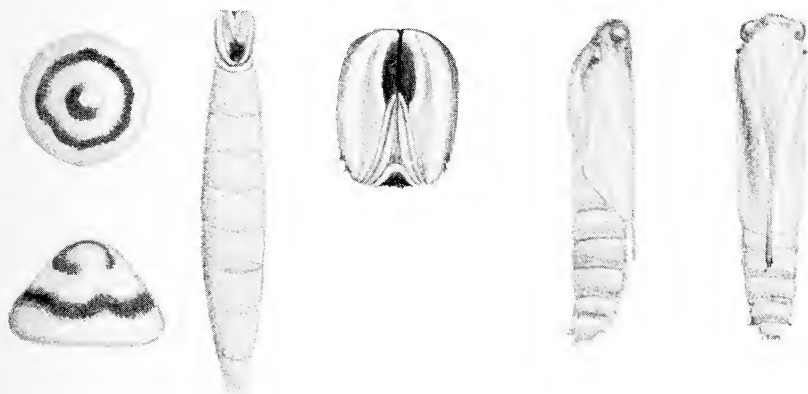


Fig. 1. The early stages of *Euphyes vestris metacoment*. Mature larva and enlarged view of the head capsule. Pupa, lateral and ventral aspect. Ova, dorsal and lateral aspect.

Pupation occurred in a white silk lined tube near the base of the plant composed of four leaves fashioned into the shape of a tube. The pupa rests in a vertical position, head up, with a 10 mm. topping of foamy silk and another thinner pad of about 5 mm. thickness beneath. The pupa is very active with the abdomen rotating rapidly in a circular motion when disturbed.

The larvae emerged 17 June and pupated 26 July. The life cycle was completed 10 August with the emergence of two normal sized males. The time spent in the first four instars was constant with seven days spent in each. The final instar lasted 12 days with two days of this time spent spinning the cocoon. I would like to express my thanks to WILLIAM HOWE of Ottawa, Kansas, who drew the illustrations that accompany this article and to Dr. JOHN R. REEDER of Yale University who kindly identified the host plant.

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THE HABITS AND LIFE HISTORY OF *AMBLYSCHIRTES NYSA* (HESPERIIDAE) IN MISSOURI

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THIS INCONSPICUOUS SKIPPER occupies a rather limited range in the United States, occurring from Arizona to Texas and north into Kansas and Missouri. I first noted *Amblyscirtes nysa* in Missouri in 1955. It was extremely abundant that year and has been observed every year since in varying numbers. In Missouri the records are all from the western counties of Clay, Jackson, Cass and St. Clair. While other members of the genus found in this region are forest denizens, *nysa* is found in open areas. The great majority of specimens collected to date have been taken in city yards and gardens. This skipper is probably overlooked in many areas due to its habits of flying only a few inches above the ground and visiting only low growing flowers. It is often found resting on the bare ground where the mottled pattern on the underside of the wings make it almost invisible. This species is an avid flower visitor with rather peculiar tastes, especially attracted to Lima Bean (*Phaseolus*), Cantaloupe (*Cucumis*), Blue Spirea (*Caryopteris icana*) and Yellow Marigold (*Tagetes*). If any of these species are present *nysa* will ignore other flowers growing in the same area. The status of this skipper in Missouri is still uncertain. There is some evidence of overwintering larvae in this area but spring specimens are so rare that it seems likely their numbers are augmented by migrators from milder areas further south. There are at least four broods produced in this area, from May to October, with considerable overlapping in July, August and September. Host plants in Missouri are the following grass species, *Echinochloa pungens*, *Setaria glauca* and *Digitaria sanguinalis*. Wild females have been observed ovipositing on all these plants but the preferred host seems to be Crab Grass (*Digitaria*). The following description is based on a series of larvae reared on *D. sanguinalis* during September and October 1963.

OVA: Eggs are deposited at random on the leaves and stems of the host grass in the late afternoon, usually between 3:00 and 5:00 p.m. Egg small, about 1 mm. in width and height. The egg is hemispherical, shiny white and unmarked under 25 power magnification. The egg shell is devoured upon emergence.

FIRST INSTAR LARVA: Body white, unmarked, sparsely covered with short white bristles. Prothoracic shield black. Head shiny, unmarked and without visible hair. The first day the emerging larvae crawl to a leaf tip and make a semi-tent by pulling the leaf edges nearly together and attaching several silken strands to hold them in place. Small notches are eaten from the sides of the grass blade below the tent.

SECOND INSTAR LARVA: Body color medium green with a darker mid-dorsal line. Head black with a deep cleft dorsally at the epicranial suture. Prothoracic shield black. Body thinly covered with minute white hairs. In this instar the larvae live in a rolled up leaf tent of about 10 mm. length.

THIRD INSTAR LARVA: Body color pale yellow green, thickly sprinkled with minute black bristles. Tenth abdominal segment and abdomen paler green. First and anal spiracle marked with a black dot. Prothoracic shield pale green with a narrow black edge. Head pale caramel brown and cream in color. The epicranial suture is clearly outlined with darker brown lines. There are elongated vertical areas edging the epicranial suture from the crown to the base of the mandibles. The outer edges of the epicranial plates are cream colored nearly to the crown. The frons is cream colored. There is a wide dark brown band at the back of the head, ringing the prothorax. The mandibles are dark brown.

FOURTH INSTAR LARVA: Body color pale green, thoracic and abdominal segments nine and ten paler green. Body with a whitish overcast and thickly covered with minute black setae. Prothoracic shield white with two short, verticle black subdorsal dashes. Spiracles unmarked. Head white with numerous tan colored lines. The epicranial suture is outlined with a tan colored line and a band of the same color runs from the base of the jaws up the sides of the epicranial plates to the crown. A tan colored line parallels the vertical stalk of the epicranial suture at each side. The mandibles are very dark brown. Frons white with tan etchings. A tan colored band circles the back of the head, broken dorsally. Larvae in this instar live in a 2½ inch tent located midway up a grass blade.

FINAL INSTAR LARVA: Length 20 mm. Body color pale cabbage green with a dark green middorsal stripe. Many minute green blotches are visible over the body. Each segment of the body contains numerous wrinkles which give the larva the appearance of having many tiny rings circling the body. Prothoracic shield pale smooth green. The first and anal spiracles noticeable as small brown dots. Color of head creamy white. Frons grayish white with brown inner tracings. The vertical stalk of the epicranial suture is narrowly banded with bright orange brown. There is a tapered vertical dash of the same color rising from each arm of the epicranial suture. Another orange brown band starting at the base of the jaws curves up across the epicranial plates to the crown. The jaws are white with brown edging. There is a very narrow brown band on the back of the head circling the prothorax.

PUPA: Length 18-19 mm. width at wing cases 3.5 - 4 mm. Bright cream in color, a slight orange brown shading at the head. There are numerous orange brown bristles on the head and abdomen. Spiracles conspicuous pale brown dashes. Cremaster a single sharp point, bright orange brown in color. Pupation occurs in a sealed case made from a leaf of the host plant. The cocoon is thinly lined with silk. The leaf used for the cocoon is cut from the plant and lies among the rubbish at the base of the grass plants.

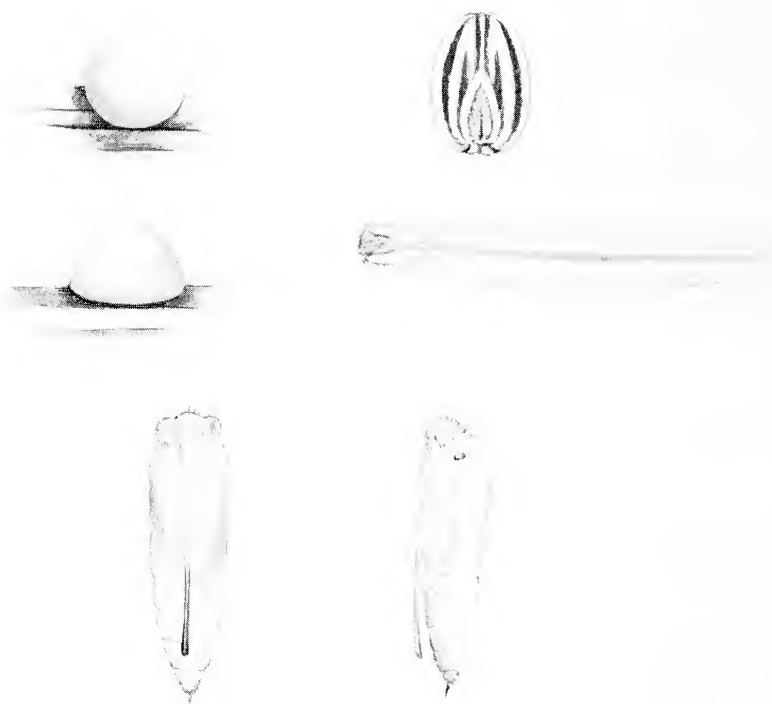


Fig. 1. Early stages of *Amblyscirtes nysa* Edwards. Ova, dorsal and lateral view. Mature larva, dorsal view and enlarged view of the head capsule. Pupa, ventral and lateral view.

By 8 October all larvae had sealed themselves into a cocoon. About 80 percent pupated and emerged 10 to 13 days later. The remaining larvae went into hibernation until late the following April when pupation occurred, triggered by the first warm spring rains. All of these pupae produced adults by the 15th of May. The average time spent in each instar was four to five days, the fifth instar requiring seven days, one of which was used in construction of the cocoon. I would like to thank WILLIAM HOWE of Ottawa, Kansas, for the accompanying illustrations and Dr. JOHN R. REEDER of Yale University for determination of the host plants.

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GENETIC RELATIONSHIPS OF *PAPILIO INDRA* AND *PAPILIO POLYXENES*

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CLARKE AND SHEPPARD (1955) HAVE SUGGESTED that *Papilio indra* Reakirt and its subspecies may have been isolated from the other North American members of the *Papilio machaon* complex longer than the latter have from each other. This assertion was based on the dissimilarity in genitalia, the lack of marked sexual dimorphism, and the fact that several subspecies have evolved. To date, the genetic relationships between *P. indra* and other *P. machaon*-like forms have not been examined. The present paper discusses the results of crosses between two California *P. indra* subspecies and *P. polyxenes* from the eastern U. S.

THE CROSS ♀ *P. POLYXENES* X ♂ *P. INDRA FORDI*

On April 30, 1962, larvae of *Papilio indra fordii* were collected on *Cymopterus panamintensis* var. *acutifolius*, at Cottonwood Canyon near Cottonwood Spring, Joshua Tree National Monument, Riverside County, California. From the pupae obtained, a male emerged on February 11, 1963. A female *P. polyxenes* emerged on February 16 from a pupa from stock collected by Mr. Kent Wilson at Lawrence, Kansas, in the fall of 1962. The *P. i. fordii* was hand-paired with the *P. polyxenes* on February 17, and copulation lasted 47 minutes. The female *P. polyxenes* was confined over *Foeniculum vulgare*, and laid 52 eggs. All eggs showed characteristic fertility change (the embryo visible as a reddish-brown band around the egg.) However, only two darkened; of these two, one hatched. The larva appeared to be very weak, and moved around with difficulty. Two hours after hatching it died, failing to nibble at *Foeniculum* and *Tauschia* which were offered to it.

THE CROSS ♀ *P. INDRA PERGAMUS* X ♂ *P. POLYXENES*

A female *Papilio indra pergamus* emerged February 14, 1964, from a pupa sent by Mr. Stan Dvorak, ex larva from Tecate Peak, San Diego County, California. This female was hand-paired the same day to a 24-hour-old *P. polyxenes* male, which emerged from a pupa obtained by Mr. Robert Colborne at Columbus, Ohio, in 1963.

Copulation lasted 68 minutes (approximately the usual time for *P. polyxenes* X *polyxenes* pairings). Only four eggs were laid, and there was no fertility change.

DISCUSSION

The assertion (Remington, 1960) that imaginal color patterns are poor phylogenetic indicators in many *Papilio* seems to be applicable to these two black *Papilio* species, *indra* and *polyxenes*. From a genetic standpoint, the two southern California subspecies of *P. indra* are apparently quite distinct from the eastern *P. polyxenes*. The data of Clarke and Sheppard (1953) indicates that F₁ hybrid adults can be obtained from crosses between *P. polyxenes* and *P. brevicauda*, *P. zelicaon*, and *P. machaon*.

SUMMARY

1. The cross ♀ *P. polyxenes* X ♂ *P. indra fordii* showed high egg fertility, but only 4% of the eggs indicated late larval development. The one hatched larva was weak and died within two hours.

2. The cross ♀ *P. indra pergamus* X ♂ *P. polyxenes* gave no fertile eggs.

3. The results may indicate a rather distinct genetic relationship between these two *P. indra* subspecies and *P. polyxenes*.

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ADULT OVIPOSITION RESPONSES IN *PIERIS RAPAE*

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Lepidoptera Foundation, Arcadia, and
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DIFFERENTIAL RESPONSES of the larvae of *Pieris rapae* to various food plants, and to various mustard oils have been shown previously (Hovanitz and Chang, 1962, 1963, 1964). The responses of the adult females with regards oviposition have been somewhat a different problem, in as much as there is involved not only an odiferous attractant, but also, the physical condition of the substrate. In this paper, several experiments are described, each of which tests females of *Pieris rapae* for a different environmental factor related to oviposition. All of these experiments were carried out by the junior author.

TEXTURE OF MATERIALS

The response of females to different textured materials was tested by covering small potted mustard plants (as the odiferous attractant) with various substances. These included white filter paper, wax paper, marquisette, plastic film with minute holes and an agar coating. As a control, one plant was left uncovered. These plants were placed in a cage, 46cm X 46cm X 20cm, along with five female *P. rapae*. After five days, the number of eggs laid on each plant, covered or not, was counted. The females were mated before the experiments were begun and fed diluted honey daily.

The results (Table 1) indicate that the white filter paper was a poor attractant. If there were no difference in attraction of the six plants, the total eggs (1900) would be equally divided into 316.67 eggs per plant, deviating only by chance. The deviation for the white filter paper is —288.67 eggs, a very significant quantity. The significance of the deviation on the remainder has been tested by χ^2 , using the hypothesis that the

¹Aided by a grant from the National Science Foundation, Washington, D. C.

	Texture	N
1.	White filter paper	28
2.	Wax paper	300
3.	Agar coat	342
4.	Plastic sheet with holes	363
5.	Marquisette	417
6.	Uncovered	450

Table 1. Oviposition responses of Pieris rapae to the different materials covering mustard plants. Number of eggs.

	Position						
	1	2	3	4	5	6	Total
No. eggs	404	543	561	515	553	526	3102
Percent	13.0	17.5	18.1	16.6	17.8	17.0	100

Table 2. Oviposition responses to the direction of the sun and the wind. (Fig. 1) Eggs laid by 20 females in 10 days.

five plants had an equal chance for being the recipient in egg laying. The deviation of each plant from the expected number of eggs (374.4) was calculated. The χ^2 value of 435 for 4 degrees of freedom gives a probability greatly less than 1 chance per 10,000 that such deviation might have occurred due to chance alone. Testing for a single plant (covered with wax paper) having a deviation of 74.4, indicates a χ^2 of 18.47, $p = < .0001$ that even this single deviation would have occurred due to chance alone. A plant having a deviation of only 42.6 (covered with marquisette indicates a χ^2 value of 6.06, $p = .015$ that this deviation could have occurred due to chance alone. It is clear that all the plant coverings create a significant decrease in the number of eggs laid as compared with no covering at all, but that based upon chance alone, agar covering, plastic covering and marquisette are not highly significantly different, one from the other. Nevertheless, on the basis of the figures, the coverings least offensive to the female *Pieris* are (in order):

marquisette (probably because of the large holes for dissemination of odors and moisture.)

plastic film with holes (probably because of the small holes for dissemination of odors and moisture).

agar coat (probably because of its permeability).

wax paper (probably because of its permeability).

Most offensive is white filter paper.

ARTIFICIAL SUBSTRATES

In order to test the effects of various odiferous substances, an artificial substrate has been designed which will be attractive to the females, will permit the odors to be effective and will not be wet so as to gum up the legs and wings of the adult. This was done by matching the surface of a leaf as much as possible by providing a smooth surface (plastic film), partially permeable (full of minute holes) and with a moist gelatinous material underneath (agar gel). The cover reduces the rate of evaporation, prevents the wings and legs of the insect from becoming trapped and permits a smooth hard surface for egg attachment.

The substrate was made out of a shallow plastic dish 10cm. in diameter with 30cc water holding capacity. A medium consisting of 1.5% agar and water, together with varying amounts of attractant and colors was provided.

Each such dish was mounted on a cork placed on top of a 120cc flask and six such flasks were arranged circumferentially in a marquisette cage 46cm X 46cm X 20cm in size (Fig. 1, 2).

In each of the experiments, the medium was changed and the number of eggs was counted daily (Fig. 4).

The adults used in all the experiments described in this paper were from a kale-strain described in previous papers (Hovanitz and Chang, 1963).

The data indicated in all subsequent tables are based on 10 days cumulative results, as the number of eggs laid each day by the females varied due to changes in weather conditions and age of the females.

EFFECT OF DIRECTION OF SUN AND AIR MOVEMENT

The purpose of this test was rather coincidental to later ones, namely to test whether or not the plants in the various geographical positions in the cage would be affected by the southerly position of the sun as it moved from east to west during the day; also, to test any possible effect of a unidirectional air movement in the greenhouse.

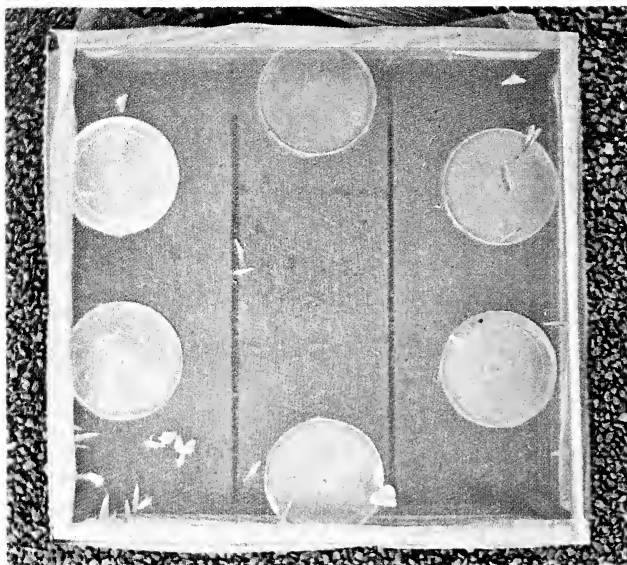


Fig. 1. Oviposition cage from above showing six different colored media covered with plastic film.



Fig. 2. Oviposition cage from side showing media plaques and butterflies.

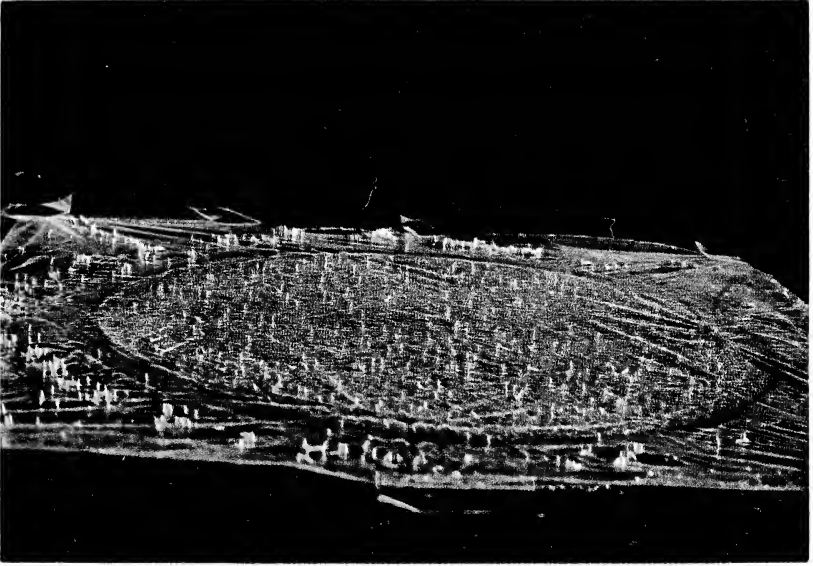


Fig. 3. Eggs and newly hatching larvae on plastic film from top of artificial medium plaque. Note the many eggs around edge. These are normally laid under the edge but are here shown turned up as the plastic film is straightened out.

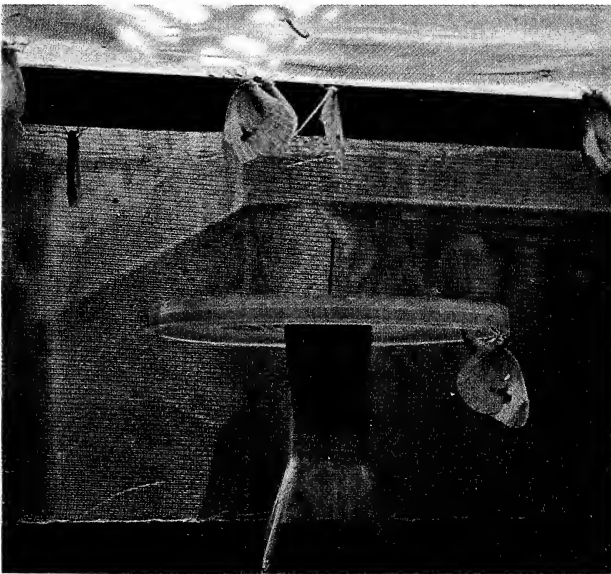


Fig. 4. Close-up of single artificial medium unit showing female laying egg.

Six substrate dishes were arranged in the cage circumferentially, and numbered in order starting from number 1 at the north, and number 4 at the south (Fig. 5). Thus, numbers 2 and 3 were at east side and numbers 5 and 6 at the west side. The air movement was in the direction from south to north.

The test dishes were all loaded with an identical artificial substrate for egg laying, which was very successful. Each medium contained a 2% water soluble fraction of ground mustard seeds (*Brassica nigra*), 0.33 percent of green food-coloring fluid and 1.5 percent agar solution.

The water soluble fraction of ground mustard seeds was prepared in the following way:

For six media dishes, six grams of finely ground mustard seeds are used. This is shaken continuously for five to ten minutes and then filtered. Each dish contains 6cc of such extract, mixed with 24cc of green-colored agar solution. After cooling and solidification, the dish is covered with a plastic film which has previously been poked full of tiny holes by insect pins.

Three thousand, one hundred and two eggs were laid by twenty females in this experiment. These were distributed in the six positions as shown in Table 2. Position number 1 had the fewest eggs at 404, while position number 4 was second lowest at 515. With the assumption that all positions had an equal chance, the data were tested by chi-square, giving the result: $\chi^2 = 32.4$ (5 degrees of freedom), $p = < .0001$, a very significant deviation from chance.

Testing the assumption that perhaps only number 1 deviates significantly from the remainder, a test was made on the remaining five. These gave a χ^2 value of 7.6 for 4 degrees of freedom, $p = .07$, which is not highly significant. This would indicate that the basic deviation is in number 1, away from the sun and the direction of air movement. However, since number 4 is second lowest, number 1 and number 4 were combined and compared with a combination of 2, 3, 5, 6. The four just mentioned are at "sides" as compared with 1 and 4 which are at the "front" and "back" as compared with the direction of sun and air movement. Combined in this way, number 1 and number 4 were significantly different from the others, $\chi^2 = 19.2$ (2 degrees of freedom), $p = < .0001$.

In all subsequent tests, therefore, to eliminate the effects of this unidirectional environmental factor, the cage was rotated ninety degrees daily. The cage was therefore rotated completely

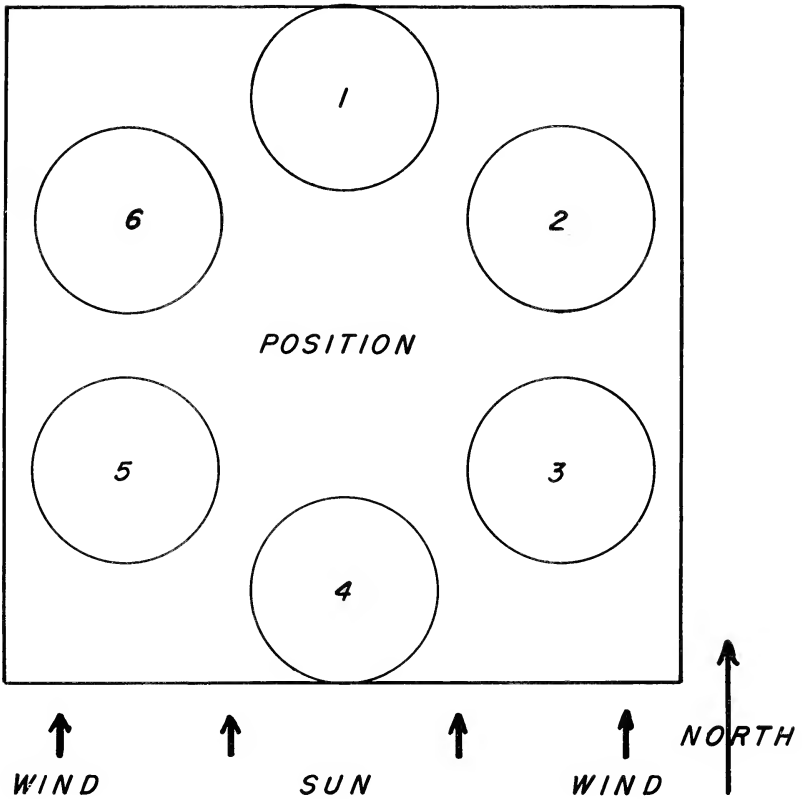


Fig. 5. Diagram illustrating the relative positions of artificial oviposition mediums in relation to direction of wind movement and sun direction in test area.

2½ times during the course of the experiment. In any event, the maximum difference between any of the positions was 5 percent of the total eggs laid.

RESPONSE TO COLOR

To test the response of the female *Pieris rapae* to color of the substrate, media were prepared as above, 2 percent water soluble fraction of mustard seeds, 0.33 percent color fluid and 1.5 percent agar solution.

Red, yellow, blue and green colors were obtained directly from Shilling food colors (McCormick and Co., Inc.). Yellow-green color was obtained by mixing the two in a 1 : 1 ratio. Different shades of blue and green were obtained by blending these two in different proportions, for example, G₁ B₄ was one part green to four parts blue. No color was added to "white" color medium (Fig. 1).

Experiment Number 1: The colors red, yellow, white, blue, and yellow-green were tested, using 15 females for egg laying. Of the total of 734 eggs obtained (Table 3), 630 or 85.83 percent were on yellow-green, 67 or 9.12 percent were on blue and 35 or 4.77 percent were on white. Yellow and red were negligible with only one each. Since yellow alone was insignificant, the high selection on yellow-green is presumed to be selection for green.

Experiment Number 2: The colors green, yellow-green, blue, white, yellow and red were tested. Of 1114 eggs, 478 or 42.9 percent were on green, 356 or 30.2 percent were on yellow-green, 260 or 23.3 percent were on blue, 40 or 3.6 percent were on white and none at all were on yellow or red. It appears as if green is most favored and that blue is second. Yellow is not only not favored but may be repellent, as shown by the addition of yellow to green, decreasing the effectiveness of the green. Here, however, since the green is combined 1 : 1 with yellow, the decrease may be due to 50% reduction in the quantity of green pigment.

Experiment Number 3: Green, blue and various combinations of these two were tested in this experiment. Green was six times more effective than blue (18 percent for green over 3 percent for blue) in a total of 620. A series of combinations of blue and green were made up ranging from one part green: 4 parts blue to 4 parts green: 1 part blue. The addition of blue to green had a slight (or no significant) effect on raising the selective response (18 percent to 19 percent). The proportion of 2 parts green to

A.

	Yellow green	Red	Yellow	White	Blue	Total
No. eggs	630	1	1	35	67	734
Percent	85.83	0.14	0.14	4.77	9.12	100

15 females

B.

	Green	Yellow green	Blue	White	Yellow	Red	Total
No. eggs	478	336	260	40	0	0	1114
Percent	42.9	30.2	23.3	3.6	0	0	100

15 females

C.	Blue	G ₁ B ₄	G ₂ B ₃	G ₃ B ₂	G ₄ B ₁	Green	Total
No. eggs	21	86	165	117	120	111	620
Percent	3.4	13.9	26.6	18.9	19.4	17.9	

6 females

Table 3. Oviposition responses of Pieris rapae to different colors.

three parts blue was significantly better in eliciting a response, however, to 26.6 percent of the total eggs. Any greater blue (or decrease in green) however, brought about a drop in selection (14 percent for 1 part green to 4 parts blue). The fact that blue plus green has a greater effect than either alone is a point of interest.

RESPONSES TO CONCENTRATION OF EXTRACT

Two tests were made on varying amounts of mustard-seed extract in the media. For example, 2 percent extract media contained 6cc of 10 percent mustard extract and 24cc yellow-green colored agar solution; the 4 percent extract media contained 12cc of 10 percent extract and 18cc agar solution. In addition to these, a test was made by adding 0.1 gm. of finely ground mustard seeds directly to the agar solution, and controls of 6cc distilled water were used.

In the first series of tests, test plates consisted of the extract concentrations ranging in percentage from 0.1, 0.5, 1 and 2, ground mustard-seed and distilled water. The 2 percent concen-

tration was significantly higher than all the others with response at 31 percent of all eggs (70/225); the lowest was the "ground mustard-seeds", 8 percent (17/225) (Table 4).

A.	[5 ♀♀]	percent concentration				0.1 gm. grnd. must. seeds	H ₂ O	Total
		0.1	0.5	1.0	2.0			
	eggs	26	30	43	70	17	39	225
	percent	11.5	13.3	19.1	31.1	7.6	17.3	
B.	[16 ♀♀]	percent concentration				H ₂ O	Total	
		1.0	2.0	4.0	6.0			
		eggs						
	eggs	208	459	408	369	213	1657	
	percent	12.6	27.7	24.6	22.3	12.9		

Table 4. Oviposition responses of Pieris rapae females to different concentrations of water soluble fractions of ground black mustard seeds.

	Test A		Test B	
	Number of eggs	Percent	Number of eggs	Percent
Water soluble fraction of mustard seeds	553	72.19	1564	74.3
Distilled water	213	27.81	541	25.7
Total	766	100	2105	100
No. females	10		20	

Table 5: Oviposition responses of Pieris rapae to the artificial substrate with and without attractant.

In the second series of tests, the concentration of extract was increased to percentages of 1, 2, 4 and 6, again with distilled water as a control. The 2 percent concentration was again highest in eggs deposited although 4 and 6 percent were not far behind. One percent and distilled water were lowest (Table 4).

Two tests were made to detect the ability of the females to distinguish between plates with and without mustard-seed extract. The fact that plates in the previous experiments had eggs laid on them even though no extract was present leads one to believe that proximity of extract-containing plates induces oviposition activity, even on plates not actually permeating mustard odors. Three plates of 2 percent extract with 1.5 percent green colored agar were alternated around the cage with plates using only the colored agar.

In the first test, of 766 eggs laid, 553 or 72 percent of the eggs were laid on the mustard fraction plates (Table 5).

In the second test of 2105 eggs laid, 1564 or 74 percent were laid on the mustard extract plates, approximately the same proportion as in the first test (Table 5).

The interesting observation here is that about one-fourth of all the eggs were laid on the plates without any attractant. This would indicate that the moisture, and attractive qualities of the plastic film alone, were sufficient, although one can not rule out the proximity of adjacent plates containing mustard extract as having some effect here.

COMPARISON OF ARTIFICIAL MEDIA AND NATURAL LEAVES

There is no very good way of comparing directly the comparative attractive qualities of the artificial media plates and leaves of the *Pieris* host plant. Nevertheless, an indirect method is possible by placing in one cage a full set of six plates with attractant and color at optimum concentrations. In another cage of identical size and conditions are placed six small black mustard plants. In each of these two cages are placed 15 adult females for egg laying over a comparable period of time where the two cages are set side by side.

The main difference in physical aspects of the two set-ups is the multi-level aspect of the leaves on the plants as compared with the single-level aspect of the plates (Fig. 3).

Two experiments were arranged. In the first (Table 6), 3974 eggs were laid of which 1829 (46.02 percent) were laid on

artificial media. In the second, 5615 eggs were laid of which 2689 (47.89 percent) were laid on artificial media.

These data show that the artificial medium is nearly as successful as the plants themselves in inducing oviposition.

Table 6A	Exp.	No. females	Total no. eggs	Eggs/female
Artificial media				
	1	15	1829	121.9
	2	15	2689	179.3
Total		30	4518	150.6
Black mustard				
leaves	1	15	2145	143.0
	2	15	2926	195.1
Total		30	5071	169.0

Table 6 B	artificial media		leaves		Total
Experiment 1	1829	46.02	2145	53.98	3974
Experiment 2	2689	47.89	2926	52.11	5615

Table 6 : Oviposition responses of Pieris rapae to the artificial media and the natural food plant.

	-5	-6	-7	-8	H 0	2 percent	Total
	10	10	10	10	2	mustard fraction	
No. eggs	241	125	119	144	215	593	1437
Percent	16.8	8.7	8.3	10.0	15.0	41.3	
25 Females							

Table 7: Oviposition responses of Pieris rapae to various concentrations of allyl-iso thiocyanate.

RESPONSE TO ALLYL-ISOTHIOCYANATE

The media as previously compounded was made up, substituting various dilutions of pure natural mustard oil (allyl-isothiocyanate) produced by Fritsche Brothers, Inc., New York. All media contained 1.5 percent yellow green agar solution. Dilutions of the mustard oil were 10^{-10} , 10^{-6} , 10^{-7} and 10^{-8} . In the same experiment were placed plates containing 2 percent mustard seed fraction and water alone.

Of a total of 1437 eggs, 593 or 41.3 percent were laid on the one plate having mustard seed fraction. The next highest was the 10^{-5} dilution (241, or 16.8 percent) which was not much different from water (215 or 15.0 percent). The other three concentrations of mustard oils were considerable less effective than water, inducing ovipositions of 119, 125 and 144 eggs respectively. It would appear that these concentrations of mustard oil are actually repellent to the female *P. rapae* despite the inducements to the larvae.

SUMMARY

1. Differential responses of adult female *Pieris rapae* are shown to various substrata, and other environmental factors.

2. Mustard plants were covered with marquisette, plastic film with holes, agar coating, wax paper and white filter paper. Egg laying was greatest on the coverings in the order shown.

3. A method of producing a desirable artificial substratum is described.

4. The effect of the sun and air movement was shown to be significant.

The effect of different colored substrata was tested. Green is preferred greatly with blue second in preference. Yellow may be repellent and red is of no significance. A combination of green-blue was found to be more favored than green alone but this may be due to a lowered concentration of green.

6. Optimum concentration of mustard seed soluble extract was tested. A 2 percent concentration was found most favorable.

7. In a comparison of artificial media with natural leaves, natural leaves were found only slightly superior to the artificial as judged by the number of eggs laid. This may be due to surface area exposed, however.

8. Various concentrations of allyl isothiocyanate were tested. None elicited better response significantly higher than water alone, and all were lower than mustard seed soluble extract. Three concentrations indicated that the mustard oil may actually be repellent at those concentrations.

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STUDIES IN LIFE HISTORIES OF NORTH AMERICAN LEPIDOPTERA CALIFORNIA ANNAPHILAS

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THE MOTHS KNOWN AS ANNAPHILAS have intrigued many lepidopterists since Grote erected the Genus in 1873. This interest is partly due to the limited range of its components. They extend from British Columbia through the western states of Washington, Oregon, Nevada, California, Idaho, Utah, New Mexico, Arizona, and Texas. Also study is stimulated by the rarity of many species, their distinctive coloration, and their diurnal habits.

In southern California several lepidopterists — Christopher Henne, Frank Sala, William H. Evans, Charles Hogue, and the late Claude I. Smith — avid collectors and resourceful field workers, have assembled notes on the biology and ecology of California species.

Frank Sala published a short paper in the *Lepidopterists News* (1950) chiefly on habits of the genus in general, with no specific reference to life histories. Only Claude Smith had prepared systematic notes on individual species in anticipation of their being published. When he died these notes were made available to Dr. Frederick H. Rindge. This led eventually to the publication in 1952, by joint authorship, of "A Revision of the Genus *Annaphila* Grote".

This work has increased our knowledge and stimulated our interest in the *Annaphilas*. In the introduction we especially noted: "There is a particular need for life history work, and the careful study of the early stages as an aid in the proper placement and relationships of this genus within the *Phalaenidae*." (Page 191)

Since Christopher Henne was collecting and rearing members of the genus, and Comstock was illustrating and recording the results of this work, it was decided that, in response to the recommendation of Dr. Rindge, our joint efforts should be published.

We shall include such additional notes on life histories as are available, particularly the work of William H. Evans as recorded in the Rindge-Smith "Revision."

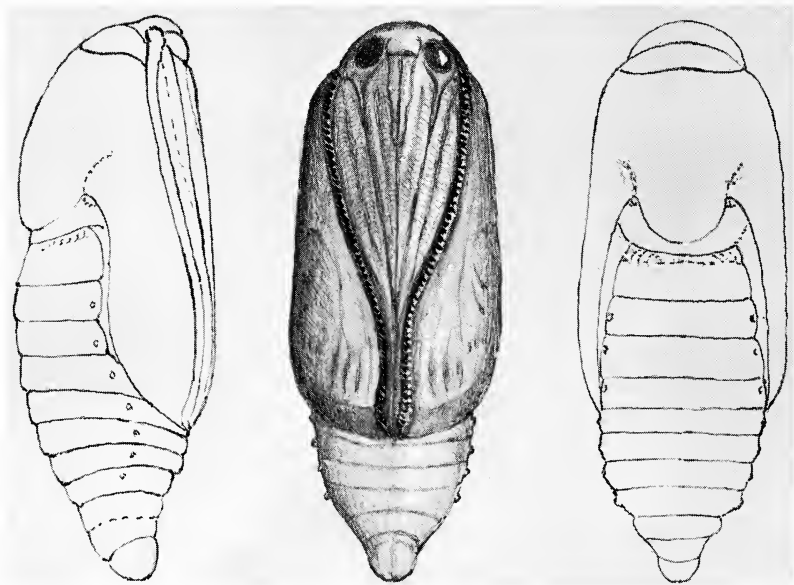


Fig. 1. Pupa of *Annaphila arvalis* H. Edw., lateral, ventral and dorsal view. X 10.

Our descriptions and illustrations are frequently based on individual specimens, and therefore do not describe variation within a given species.

***Annaphila arvalis* Henry Edwards**

This species was first taken in the "Sierra Nevada". It is not uncommon in southern California and ranges north into Oregon and Washington. The moth flies from January to April. Evans briefly described the third to fifth instar larvae; reported the food plant as *Montia perfoliata* (Donn) Howell; and stated that "pupation occurred inside hollow stems, but no attempt was made to seal the openings."

Pupa: (Fig. 1)

In 1956 Frank Sala sent us a pupa. The larva had been taken in "Latigo Canyon", Santa Monica, California. No date was recorded. An illustration was made and the following brief notes recorded.

Length, 7.5 mm.; greatest width, 2.8 mm.; head, well rounded; eyes, prominent; antennae, terminating at the margin of wings; spiracles, slightly protruding; terminal segment a round button with no cremasteric hooklets.

Ground color is light yellow-brown. The eyes, antennae, wing margins, cephalothorax and caudal tip are dark brown to black. A few buried dark spots occur across the central part of the wings, and light pencilings indicate some of the wing nervules.

Structural details not specifically mentioned are shown in the illustration. The mature insect is pictured in color by Hampson, (1910), in Vol. 9, and also by Draudt in Seitz, (1927), Vol. 7, Plate 47d.

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Annaphila abdita Rindge and Smith

This species is on the wing from February to April. It is recorded only from California. No previous data on its life history are available.

A number of eggs were secured from a confined female, taken in the Santa Monica Mountains, Los Angeles County, (elev. 900 ft.) on March 19, 1963. These hatched April 1, 1963.

Egg: (Fig. 2 A)

Width, 0.5 mm.; height, 0.4 mm.; form echinoid. The base is slightly flattened, and the micropylar depression relatively large. When first laid, the color is straw and prior to hatching it turns grayish. The surface bears from 23 to 29 ridges, running from base toward micropyle. Approximately 15 of these reach the margin of the micropylar depression. The others become obsolescent or fuse with their neighbors. The ridges are slightly irregular and each bears a line of small knobs along its crest.

We were unable to record the early instars, but on May 14 drawings and notes were made.

Mature larva: (Fig. 2 B)

Length, 14 mm.; head width, 2 mm.

Head ground color is light creamy brown, with a slight tinge of yellow. The adfrontal sutures are distinct and spotted with pinkish dots. The ocelli and mandibles are black, and the antennae

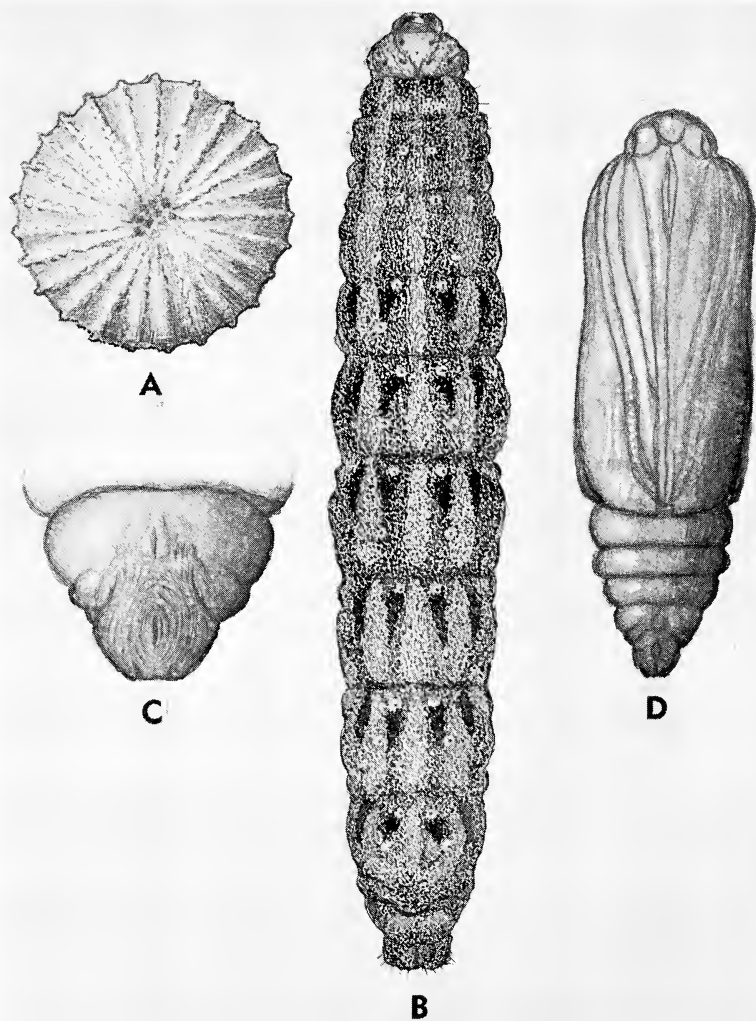


Fig. 2. Egg, larva and pupa of *Annaphila abdita*. A. Egg, superior aspect, X 65. B. Mature larva, dorsal aspect, X 9. C. Caudal segment of pupa, ventral aspect, X 33. D. Ventral aspect of pupa, X 11.

Reproduced from water color drawing by J. A. Comstock.

are yellow-brown. Lines of brown dots across the cheeks and extend from crown to lower margins.

The body ground color is light cream, heavily obscured by bands of speckled blackish brown and dull pink. There is a mid-dorsal band of dull pink made up of pink dots on the cream base. This is narrow at the cephalic end and gradually widens. It is, however, pinched in at each segmental juncture. A similar but more distinct band runs dorso-laterally. A still wider band of the same character runs stigmataly, the spiracles occurring along its upper edge. The latter are black-centered with very narrow rims. Below the stigmatal band, the body is spotted with brown dots on a light brown base, the latter fading to a still lighter brown on the venter.

The legs are translucent light brown with darker tips. The prolegs are spotted with brown proximally and are translucent creamy brown distally. The crochets are brownish black.

The dark areas running between the dull pink spotted bands owe their heavy color to a thick sprinkling of brown-black dots over their surfaces. This is relieved on each segment by a pair of white circlets surrounding minute black centers, each of which bears a small black seta. Setae of this character occur elsewhere on the body but are difficult to discern without high magnification.

Pupa: (Fig. 2 D)

Length, 7 mm.; greatest width through center, 2.5 mm.

The color is chrome-yellow, slightly translucent. The surface texture is smooth and glistening, except for a portion of the last caudal segment. (See Fig. 2 C)

The head is well rounded and eyes are not prominent. All sutures are faintly visible. The maxillae reach almost to the wing margins and the antennae terminate 0.3 mm. short thereof. The spiracles are light brown.

The ventral surface of the last caudal segment is sub-ovate, slightly flattened, and ridged around a central cleft. There are no cremasteric protrusions or hooklets.

The food plant of the species is *Montia perfoliata* Howell. Pupation occurs underground in a compact cocoon.

***Annaphila baueri* Rindge and Smith**

This species, named for William R. Bauer of Petaluma, was taken at Anderson Springs, Lake County, California and also 4 miles west of Glenbrook, Lake County.

Its period of flight is from February to April.

It is known to occur only in California.

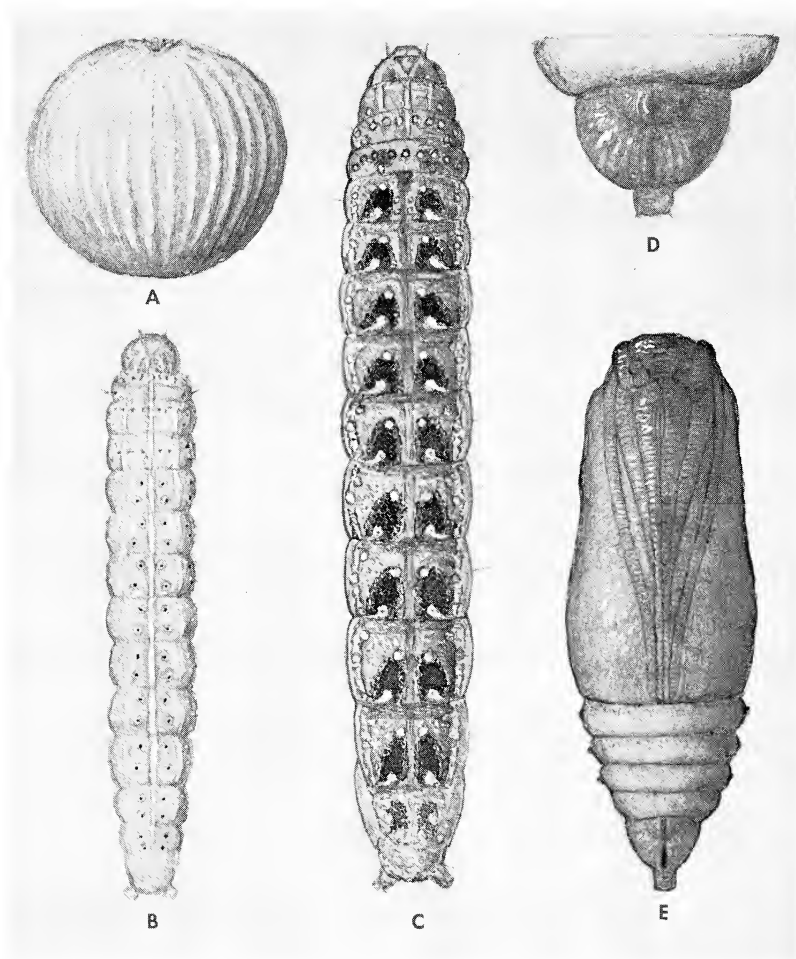


Fig. 3. Egg, larva and pupa of *Annaphila baueri*. A. Egg, lateral aspect, X 60. B. Intermediate instar larva, dorsal aspect, X 12. C. Mature larva, dorsal aspect, X 8. D. Cauda and cremaster of pupa, ventral aspect, X 18. E. Pupa, ventral aspect, X 8.

Reproduced from water color drawing by J. A. Comstock.

Eggs were collected at Cedar Pines Park, San Bernardino Mountains, (elev. 5200 ft.) from the underside of leaves of *Nemophila* sp. The plant was subsequently determined by Dr. Reid Moran as *Nemophila Menziesii* ssp. *integrifolia* Munz. An additional locality for the species is La Tuna Canyon, Los Angeles County.

Egg: (Fig. 3 A)

Globular; width, 0.4 mm.; height, 3.8 mm.

The color is light yellow with a slight tinge of light green. Numerous ridges run from the base to the micropylar area. There are approximately 30 of these ridges, but many fuse with others or become obsolescent as they approach the micropyle. The ridges are irregularly nodular along their edges, and the valleys between them are not crossed by horizontal lines. The micropyle is minute and deeply depressed.

Eggs collected April 20, 1963, hatched April 27.

First instar larva:

Body length not recorded; head width, 0.25 mm.

The color of head is black, or greenish black, wider than the first segment. The body is pale translucent green. The legs are tinged with light brown, the prolegs are colorless, with brown crochets.

Many minute and colorless setae are scattered over the body, arising from colorless nodules.

Intermediate instar: (Fig. 3 B)

The color of head is yellow-green, covered with numerous red-brown dots which are thickest in the middle areas of the cheeks above the black ocelli. The mouth parts are also tinged with red-brown.

The body is deep green throughout. There is a suggestion of a paired dark green longitudinal middorsal stripe.

Numerous white papillae occur on each segment. These are topped by black points and bear very short colorless setae.

The legs are translucent light green, as are also the four pairs of prolegs and the anal pair. All prolegs are sprinkled with black dots.

The example above described moulted May 22, 1963.

Mature larva: (Fig. 3 C)

Length, 13 mm.; width, through center, 3 mm.; head width, approximately 1.5 mm.

The head is soiled-yellow, mottled and spotted with black. The ocelli rest on a lighter ground, superior to which is a large brown area. The front is heavily spotted around the margin. The antennae are white.

The body is heavily mottled with brown and black spots and dashes, darkest on the dorsum and lighter below the spiracular area and on the venter.

The first thoracic segment has a narrow middorsal white stripe with a wider stripe on each side of it. The second and third seg-

ments have transversely placed rows of white spots, each ringed with black, and bearing short white setae. On the remaining segments each has a pair of comma-like white dashes on the posterior margin, one on each side of the middorsal area. Anterior to each of these is a large black triangular patch with a white dot at its apex.

Stigmata there is a broken white wavy line. Many white dots are scattered regularly over the body surface, each apparently bearing a short white seta. The legs and prolegs are mottled brown and black on a gray ground.

Pupation occurs underground in a compact oval cocoon formed of tough fibers, completely covered by a layer of adherent granules of earth, small pebbles, and debris. The average cocoon measures 13 mm. by 8 mm.

Pupa: (Fig. 3 E)

Length, 9 mm.; width through center, 3.4 mm.

The color is wood-brown, with portions of the head and cauda nearly black.

The surface texture is predominantly rough, due to minute wavy ridges over the head, thorax, appendages and wing cases. The abdominal segments lack these ridges, but are slightly roughened, and the anterior edge of each movable segment is pitted.

The spiracles are elevated, and dark brown. The maxillae and antennae reach to the margins of the wing cases.

The last caudal segment is hemispherical on its ventral aspect, and is regularly ridged as is shown in Fig. 3 D.

The cremaster is a small cuboid knob, slightly pointed at its two outer tips, and lacks spines or hooklets.

***Annaphila astrologa* Barnes and Benjamin**

The type locality of this species is Redington, Arizona, but the majority of recorded captures are from the southern portion of California. The insect is on the wing in February, March, April, and July. The July records suggest an abortive second brood.

Larvae were taken in Aliso Canyon, San Gabriel Mountains, (elev. 3200 ft.), Los Angeles County, and in Red Rover Canyon, southwest of Acton, Los Angeles County, (elev. 3200 ft.) in May 1963. We have not seen examples of the ovum which is yet to be described.

The food plant is (flower buds of) *Emmenanthe penduliflora* Benth.

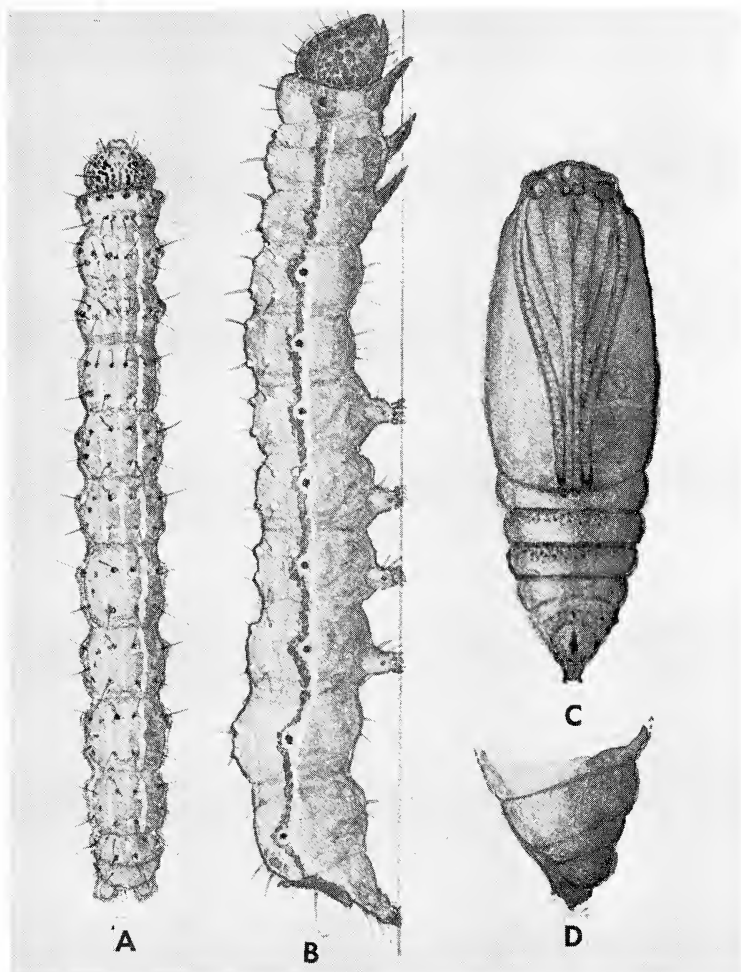


Fig. 4. Larva and pupa of *Annaphila astrologa*. A. Intermediate instar larva, dorsal aspect, X6. B. Mature larva, lateral aspect, X4. C. Pupa, ventral aspect, X6½. D. Cauda and cremaster, lateral aspect, X18.

Reproduced from water color drawing by J. A. Comstock.

Intermediate instar larva: (Fig. 4 A)

Length, 16.5 mm.; width through middle of body, 2 mm.; width of head, 1.5 mm.

The head is glistening yellow, spotted with brown. The ocelli are dark brown.

The body ground color is clear green. There is a very narrow middorsal white stripe, margined with dark green. A similar stripe parallels this on each side dorso-laterally. There is a raised stigmatal wavy white line.

The spiracles are brown-centered with white circlets. The legs are green proximally, shading to brown on the tips. The prolegs are green with brown crochets. The venter is green. There are numerous white setae scattered over the body, each arising from a minute brown point resting on a white circlet.

Mature larva: (Fig. 4 B)

Length, 28 mm.; body width, 3 mm.; head width, 1.75 mm.

The ground color of the head is dull yellow. It is heavily sprinkled with brown dots. The mouth parts are darker, and the ocelli white.

The body ground color is uniform green. There is a paired longitudinal middorsal line of dark green, formed partly of dots and dashes. In the center of this line there are spots of a lighter green. A faint suggestion of a dorso-lateral whitish line is present.

Stigmatically there is a wide sinuous band of spotted dark purple and white, bordered inferiorly by white. The dark-centered spiracles are ringed with white, and are in contact with the marginal white line on their lower edges. The venter is green, the legs spotted with brown, and the prolegs green with brown crochets.

It is noted that there is little difference between the intermediate instar and the final, whereas in several other species there is strong contrast.

In captivity the larvae pupated on the floor of the rearing cage underneath pieces of bark in an oval cocoon formed of soil particles and silk adherent to the bark.

Pupa: (Fig. 4 C)

Length, 10 mm.; width through center, 3.5 mm.

The color is predominantly deep brown, with the thorax shading to black. There is a middorsal longitudinal black band. The minute quadrate cremaster is also black.

The head, thorax, and appendages are finely rugose or minutely ridged. Most of the abdominal segments are smooth, but the movable segments are pitted along their anterior margins. The maxillae extend to the wing margins, and the antennae terminate 0.75 mm. short thereof.

The cremaster shows more clearly on lateral aspect (see Fig. 4 D). It bears minute spurs on the corners, but no hooklets.

***Annaphila ida* Rindge and Smith**

This species is thus far reported from the type locality, Chileo Creek area, San Gabriel Mountains, Los Angeles County, elevation 5700 to 5800 ft., and from Sierra Pelona Valley, Los Angeles

County, elevation 3400 ft., Mt. Pinos, Kern County, elevation 8000 ft., Cedar Pines Park, San Bernardino County, elevation 5200 ft. and Horse Flats, San Gabriel Mts., Los Angeles County, elevation 5900 ft.

It was named for the widow of Claude Smith.

Christopher Henne obtained eggs on May 11, 1963 on the under side of basal leaves of *Phacelia curvipes* Torrey. They hatched shortly before May 21, while in transit. Drawings had to be made from the empty shells. The larval exit was cut through the side of the egg, and the shell was left largely intact.

Egg: (Fig. 5 A)

Spherical, with slight flattening of the base; average diameter, 0.5 mm.

The color is reported to be straw.

The surface is crossed by ridges arising at the base, and terminating at or near the micropylar area. There are from 33 to 39 of these ridges. Their edges are studded with minute pearl-like knobs. There apparently are no cross striations running between the ridges. The shells showed no definite micropyle, and very little depression at the top of the egg.

First instar larva:

Length, 2.6 mm.; head width, 0.4 mm.

The head is black, and the body a uniform light green, with a small black cervical shield on the first thoracic segment and a transverse black dash over the dorsum on the 12th segment.

The legs shade to gray at their tips, and the prolegs are concolorous with the body.

Mature larva: (Fig. 5 B)

Length 13.5 mm.; head width, 1.5 mm.

The head is yellow, heavily sprinkled with blotches of brown. The antennae are pink, and the ocelli black.

The body ground color is cream. A narrow cream-colored mid-dorsal stripe margined with pinkish-brown runs the length of the body. Its margin forms the inner edge of a broad longitudinal band, made up of dots and dashes of light brown and cream. Lateral to this is a creamy band, lightly sprinkled with small pink dots. Latero-inferior to this is a suprastigmatal band formed of dots, dashes, blotches, and wavy lines of pinkish-brown, with the spiracles placed along its lower margin. The spiracles are black-centered, with circlets of cream-white. A broken longitudinal wavy line runs below this, fusing into a wide area of mottled cream and brown which extends downward to the line of the prolegs.

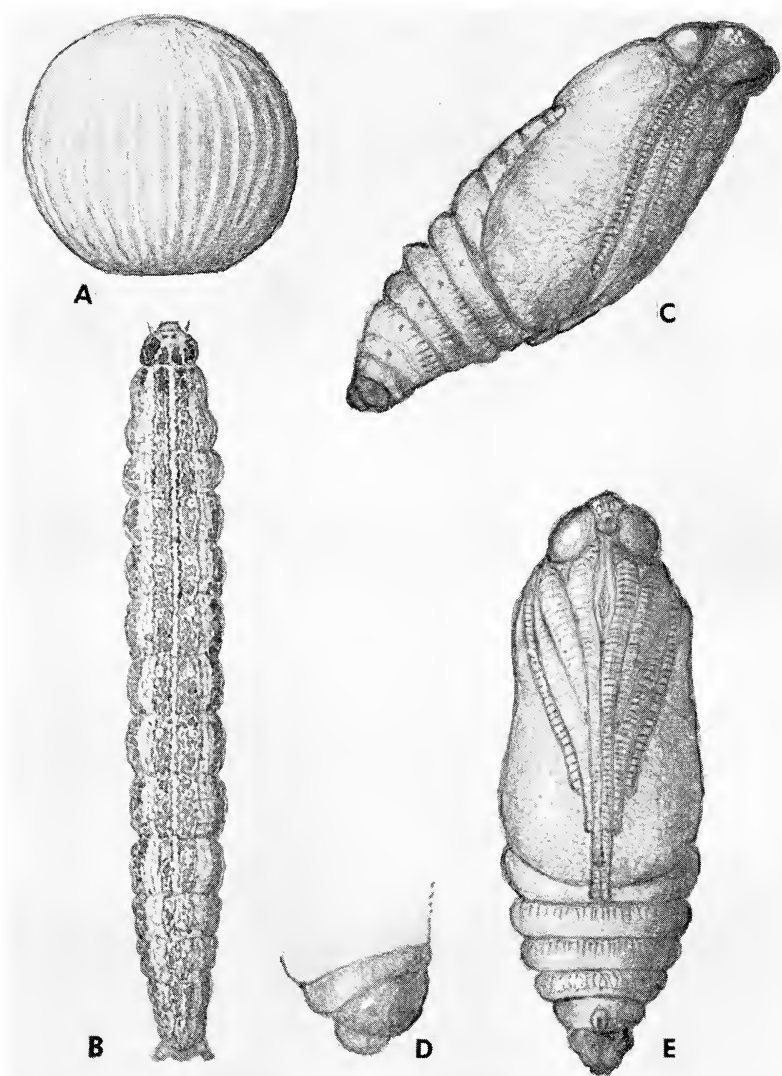


Fig. 5. Egg, larva and pupa of *Annaphila ida*. A. Egg, lateral view, X 70. B. Mature larva, dorsal aspect, X 7. C. Pupa, lateral aspect, X 9. D. Cauda, lateral aspect, X 22. E. Pupa, ventral aspect, X 9.

Reproduced from water color drawing by J. A. Comstock.

The venter is yellow-cream except on the thoracic area, where it has a tinge of green. The legs are translucent mottled cream and brown. The prolegs are cream with a delicate pink mottling. The crochets are brown.

Numerous short white setae occur on the body, but they are so small as to be practically indistinguishable without a lens. Each seta rests on a white or pinkish-white circlet with a minute black center.

Pupa: (Fig. 5 C to E)

Length, 8 mm.; greatest width through center, 3 mm. The form is robust, with an evenly tapering abdominal-caudal area, a relatively large head, and prominent eyes.

The color is dull green on the head and thorax, shading into a dull ochre-brown on the wing cases and abdomen. The green gradually fades with age. The caudal tip is nearly black.

Most of the surface is covered with minute transverse wavy ridges, those on the appendages being most prominent. The abdominal segments are partly smooth, but the anterior half of each (more particularly the movable segments) is ridged longitudinally.

The last caudal segment is shield-shaped on its ventral surface. It is cleft in the center, and the surface is rough. The small cremaster is barely visible on this aspect, but shows laterally as a rounded knob.

(See Fig. 5D).

***Annaphila depicta depicta* Grote**

Rindge and Smith (1952) have established the type locality of *A. depicta* as "San Mateo County, California" rather than "Sonome" County, as stated by Hampson (1910).

The species flies in March and April, and ranges throughout most of California. It has also been reported from Yakima County, Washington.

Eggs were collected on the Mineral King Road, east fork of the Kaweah River, Tulare County, elevation 3200 ft., on May 3, 1963. They were found on the under side of leaves of *Nemophila pulchella* Eastwood. Young larvae later accepted *Nemophila menziesii* var. *integrifolia* Munz.

Egg: (Fig. 6 A)

Globular; width, 0.48 mm.; height, 0.32 mm.

In form it is very similar to the ovum of *Annaphila baueri*. It differs in color which is pearly-white (slightly tinged with yellow). There are from 28 to 30 ridges running from base toward

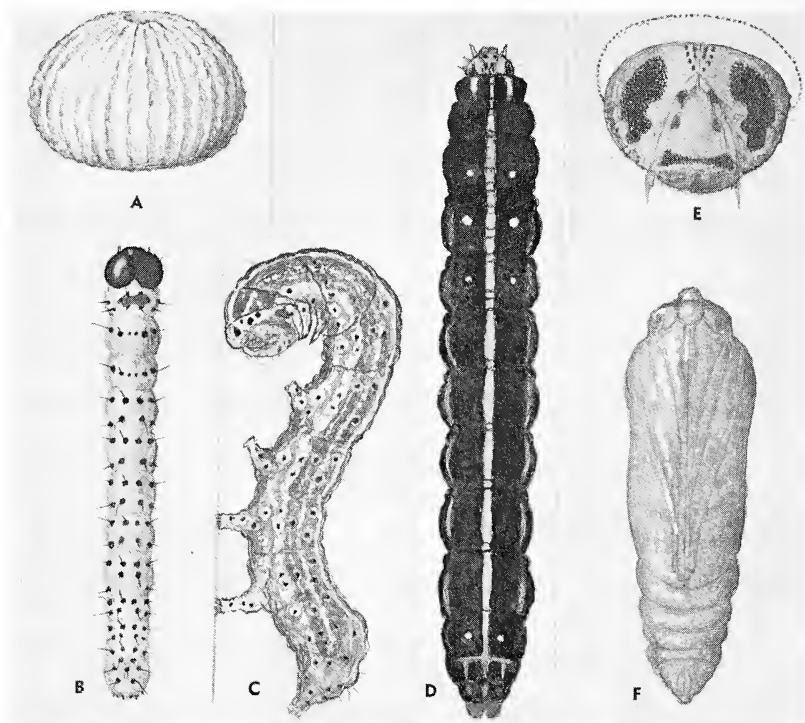


Fig. 6. Egg, larva and pupa of *Annaphila depicta depicta*. A. Egg, lateral aspect, X 50. B. First instar larva, dorsal aspect, X 22. C. Intermediate instar in resting attitude. D. Mature larva, dorsal aspect, X $3\frac{1}{2}$. E. Head of mature larva, X 6. F. Pupa, ventral aspect, X 6.

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micropyle. As with other eggs in this genus, the ridges tend to diminish in number as they approach the micropylar area. Each ridge is slightly knobbed along its edge. Apparently no horizontal striations occur between the ridges.

The base of the egg is slightly flattened, and the micropyle is not deeply depressed.

First instar larva: (Fig. 6 B)

Length, 2.5 mm.; head width, 0.25 mm.

Color of head, including mandibles, jet black. The body is deep green, except for the first thoracic and last three caudal segments, which are colorless. The first segment bears a brown cervical shield, shaped like two arrow points, joined at their bases.

Several longitudinal rows of black papillae occur on the body, each papillus mounting a white seta. On the 2nd and 3rd thoracic segments these are smaller, and run in line transversely across the segments.

The legs are tinged with gray, and the prolegs are concolorous with the body. The cauda is slightly tinged with gray. The venter is yellow.

Intermediate instar: (Fig. 6 C)

Length, 12 mm.; head width approximately 1 mm.

The ground color is dull yellow, with two large black spots on each side of the epicranial sutures and numerous small black spots on the cheeks.

The body color is predominantly olive-green above the spiracular area and mottled yellow and white below. The first thoracic segment has four large round black spots on its anterior margin and eight small black spots on its posterior edge.

There is a clearly defined middorsal white line margined with a wavy black stripe. Lateral thereto is a broad band of olive-green with a discontinuous longitudinal stripe running along its center. Inferior to this is a wide white stigmatal band with a broken narrow orange black band or series of spots coursing along its center. On the olive-green areas and also the lateral white areas there are numerous black papillae with white circlets at their bases. Each papillus bears a minute dark seta.

The legs are dull yellow with multiple black spottings. The prolegs and anal prolegs are yellow with relatively large black spots.

Mature larva: (Fig. 6 D)

Length, 23 mm.; width at 6th segment, 3 mm.; head width approximately 1.5 mm.

The head is yellow, with a heavy spotting of black on each cheek above the ocellar area. The ocelli are black on a light ivory-yellow ground. The mandibles are reddish-brown, and the antennae translucent. (See Fig. 6 E)

The body is predominantly velvety black, with a conspicuous orange-pink middorsal longitudinal stripe. The 3rd thoracic segment has a dorso-lateral small white spot. A larger spot of the same character occurs on the 4th segment, and another small spot is in line with the first two on the 5th segment. Still another similar spot occurs on the 11th segment.

A wide band of soiled orange heavily overlaid with black spots and blotches runs along the stigmatal area, the spiracles being located near its upper edge. Below this, and on the venter, the surface is mottled brownish-black. The legs and prolegs are similarly spotted. The crochets are pink.

On May 31, 1963 a larva which had moulted at the completion of its penultimate instar entirely consumed its cast-off skin.

In comparing larva of *Annaphila depicta depicta* with the description of the southern California race, *A. depicta morula*, as recorded by Evans in the Rindge and Smith Revision (1952), it is apparent that the larva of the northern race is distinctly different.

With *A. depicta depicta* pupation does not occur underground. Our larva followed the same habit as that described by Evans: cutting a channel in the pithy center of *Sambucus* stems, and using this protection in the place of a cocoon. Our single example pupated June 1, 1963.

Pupa: (Fig. 6 F)

Length, 9.7 mm.; width through center, 3 mm.

Color and texture, glistening red-brown.

The wings and thoracic appendages are translucent, allowing the underlying segmental junctures to show through.

The maxillae reach to the wing margins, and the antennae nearly so. The segmental lines are very narrow and indistinct. The eyes are relatively small, and a shade darker than the surrounding area. The cremaster is a low round knob, and bears no spurs or hooklets. The spiracles are small and inconspicuous.

The moth is illustrated in color by Hampson (1910), Pl. 147, fig. 9, and by Draudt in Seitz (1927), Vol. 7, Pl. 47c.

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Annaphila diva Grote and *Annaphila evansi* Rindge and Smith

Annaphila diva is one of the few comparatively abundant species in the genus. It is widely distributed through California, Oregon, Washington, and British Columbia. Its period of flight is from March to July. Its food plant was first recorded by William Evans (1949) as *Montia perfoliata* (Donn) Howell, and the same author gives a description of the fourth and fifth instar larvae in the Rindge and Smith Revision (1952).

As with several other *Annaphilas*, it pupates in a small cocoon.

The moth has been illustrated in Hampsons Catalogue (1910) as text figure 299, in Holland's Moth Book (1908) on Pl. 29, fig. 20, and by Draudt in Seitz (1927) on Pl. 47f.

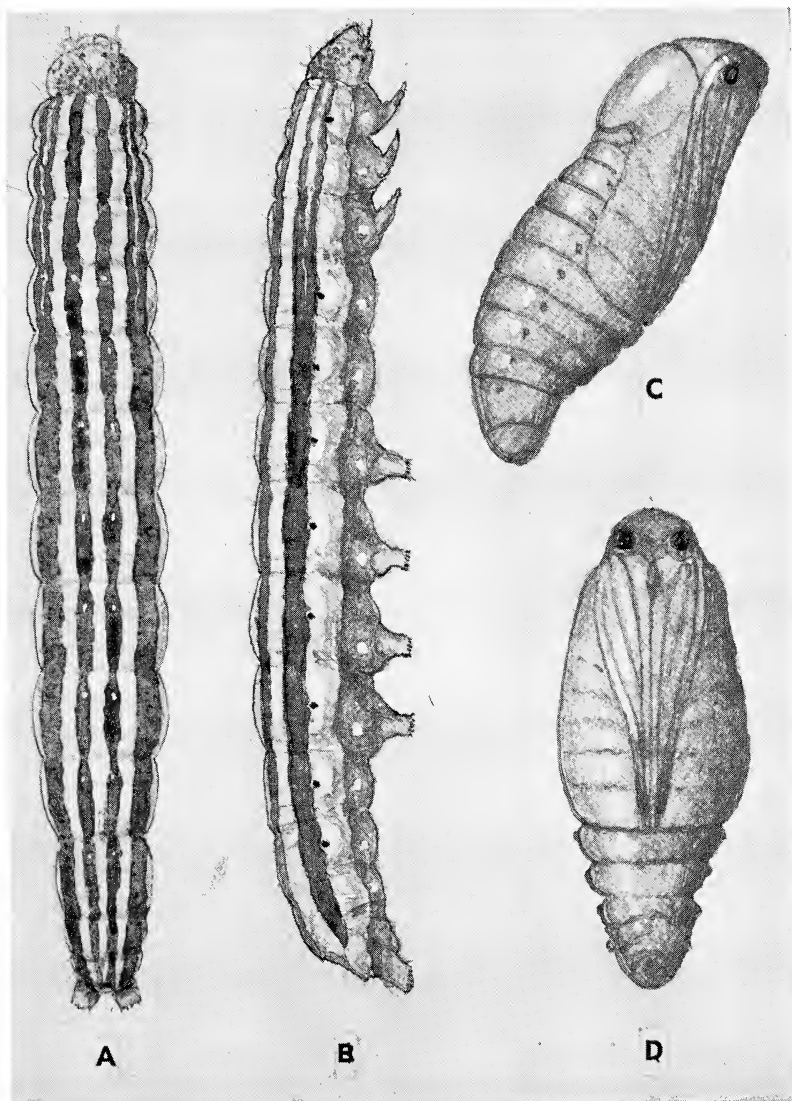


Fig. 7. Larva and pupa of *Annaphila evansi*. A. Mature larva, dorsal aspect, X?. B. Mature larva, lateral aspect. C. Pupa, lateral aspect. D. Pupa, ventral aspect, X 10.

Reproduced from water color drawing by J. A. Comstock.

Unfortunately we have not been able to secure eggs, larvae or pupae of the species, all of which still need to be illustrated.

The type locality of *Annaphila evansi* Rindge and Smith is Mint Canyon, Los Angeles County. It has also been taken along the North Fork of Chilao Creek, Los Angeles County, and in Horse Flats, San Gabriel Mountains, Los Angeles County, elevation 5900 ft. Its period of flight is from March to May. The food plants are *Linanthus breviculus* Greene and *Gilia lutea* (Benth.). As it feeds only on the bracts and blossoms, it is a difficult larva to find in the field, in spite of its relatively conspicuous coloring as a mature larva.

The moth was named for William H. Evans, who reared it from eggs collected April 13, 1950. He described the third and fourth instars very briefly as "Light chalky green, with four dark green stripes." His notes on the mature larva were more detailed: "Ground color, chalky white; stripes dark green after molting, changing to reddish brown; dorsal stripe pale, geminate, rather narrow, bounded laterally by wider dark stripes running the length of the body; spiracular stripe wide, prominent, running the length of the body, extending well dorsad of spiracles, darkest along line of the spiracles."

It is to be regretted that he did not describe the egg or pupa.

A mature larva was taken in the San Gabriel Mountains. It had assumed the final coloration of "reddish brown" stripes before our illustration was undertaken. We can therefore supplement and amplify Evans' description, and follow up with notes and a drawing of the pupa.

Mature larva: (Fig. 7 A and B)

The ground color of the head is ivory, with a slight tinge of yellow. Over the crown there are multiple small pink dots. The "geminate" dorsal stripe is separated by a white stripe, and the two pinkish-brown stripes bordering it have white dots on each segment, except in the thoracic area.

The dorso-lateral longitudinal pinkish-brown stripe starts in the thoracic area as a geminate band, but continues the remainder of the way to the cauda as a single wide band. The wide stigmal white band bears the dark contrasting spiracles on its upper edge. The lower edge of this band becomes dull orange along its margin.

The area which is about in line with the bases of the prolegs marks a change in color to a dull pink, and then fades to a lighter shade on the venter. Above each leg and proleg, and resting on

the dull pink area there is a line of round white spots, one to each segment.

Our larva perished before we were able to record measurements, probably due to lack of fresh (and blooming) food plant.

Evans did not succeed in obtaining normal pupa, or observing the fact that pupation occurs underground in an oval cocoon. Mr. Henne was successful in this respect which makes possible the description and illustration of the pupa.

The cocoon measures 9 mm. x 3.4 mm. It is covered with granules of sand and soil.

Pupa: (Fig. 7 C and D)

Length, 6 mm.; greatest width through distal quarter of wing, 2.25 mm.

The color and texture of the body is predominantly glistening translucent yellow-green. The head is tinged with light reddish-brown, and the eyes are jet black. The segmental junctures are not darkened, and are hence difficult to distinguish, except for the tips of the antennae, which are slightly tinged with brown. The maxillae reach the wing margins and the antennae terminate slightly short thereof. The spiracles are minute, and tinged with brown. Because of the translucence of the wing covers, the segmental junctures show clearly through them. The caudal tip is rounded, and bears no projections, spurs or hooklets.

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PETALUMA, A NEW GENUS,
WITH THE DESCRIPTION OF A NEW SPECIES

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University of California, Davis, California
and

California State Department of Agriculture
Sacramento, California

THIS NEW GENUS IS COMPARED with *Paramiana* Barnes & Benjamin, to which it is most closely related. It was discovered in Petaluma, California, and until recently was known from only two specimens. *Petaluma* is unique in many respects, particularly in the greatly enlarged first and last tarsal segments as well as the gigantic unguis.

The genitalic organs were stained with lignin pink to better contract the weakly sclerotized areas and the genitalia were illustrated by Miss Judith Jay. We wish also to extend our appreciation to Mr. Michael Gardner for his assistance on this project.

PETALUMA new genus

Head clothed with hair; antennae bipectinate to tip, bipectinations longest at center of antenna; frons with large triangular-shaped rounded prominence, palps with second segment possessing long hairs ventrally; proboscis normal; eyes large, rounded, moderately lashed. Thorax heavily clothed with forked hairs dorsally; dorsum with spreading divided crests, ventrally clothed in simple hairs; fore tibiae lacking armature, first and last tarsal segments greatly enlarged, as in figure 3; fore tarsal unguis very large, twice the size of mid tarsal unguis, ventrally possessing a cluster of hairs or bristles; mid tibiae with single pair of end spurs; mid tarsal unguis twice the size of hind tarsal unguis; hind tibiae possessing a pair each of medial and end spurs; hind tarsal unguis more normal size, but still rather large. Primaries and secondaries with shape as in figure 1, abdomen lacking tufts; clothed with hair both dorsally and ventrally. Genitalia as in figures 2 and 4. Type species: *P. californica* n. sp.

This genus is most closely related to *Paramiana* B. & B. *Petaluma* is much more robust and possesses a triangular-shaped rounded prominence on the frons, whereas in *Paramiana* the frons is entirely rounded; the antennae are bipectinate, whereas in *Paramiana* the male antennae are ciliate; unguis on all tarsal segments larger in *Petaluma*; the vesica of the aedeagus possesses an even band of spines in *Petaluma*, whereas in *Paramiana* there is generally one accessory group of spines plus a band of spines. At present the female sex and immature stages are unknown.

***Petaluma californica* Buckett and Bauer, new species**

Holotype male: Head clothed in various shade of brown hairs; antennae basally with tufts of dark brown hair, flagellum brown, lengthily bipectinate, bipectinations longest medially; frons with large triangular-shaped rounded prominence, appearing to be covered with a white powdery substance, frontal prominence surrounded with light yellowish brown hairs; eyes large, rounded, moderately lashed; palps clothed in both dark and light brown hairs, second segment ventrally with long black hairs. Thorax with collar tricolor, basally red-brown, medially black, tipped with light brown; dorsum with spreading divided crests of black forked hairs; ventrally heavily clothed with brownish, blackish and purplish white-tipped hairs; fore tibiae lacking armature; tarsal segments black and white banded, unguis unusually large and possessing a group of hairs or bristles; mid tibiae with one pair of black and white banded end spurs; mid tarsi black and white banded, unguis half the size of fore tarsal unguis; hind tibiae with a single pair of both medial and end spurs, unguis smaller than mid tarsal unguis. Primaries with basal area light brown, basal dash black; transverse anterior line black, geminate, inner line faint, outer line distinct, included space light brown, outcurved between veins with largest outcurved angle to base of claviform then sharply inward to vein 1, and then outcurved again between vein 1 and inner angle; median area darker brown than basal and subterminal spaces; claviform black outlined, filled with lilac; orbicular black outlined, filled with light brown; reniform quadrate, only slightly constricted, outlined in black, largely filled with lilac gray, with some white scales centrally; transverse posterior line black, faintly geminate, inner line distinct, deeply incurved between veins, from costa closely around reniform and rather strongly oblique to inner margin about one half way out from base; subterminal area light brown at costa becoming paler at "W" mark, then a dark streak below followed by a lilac white patch on inner margin; subterminal line pale brown at costa, incurved opposite reniform then a strongly marked pale "W" mark then rather even, incurved at inner margin; terminal area light for one quarter its distance from costa then dark brown, interrupted medially by white "V" with point toward basal area; terminal line black; fringes of red brown and dark brown intermixed spatulate scales; ventral surface of primaries pubescent, basally dark brown to transverse posterior line, then light brown to terminal line; remaining portion of wing with veins black outlined; terminal line present as lunules between veins. Secondaries whitish dorsally, shiny, irrorated with brown; veins outlined in brown; discal lunule brown, brown medial band running nearly parallel to outer margin; terminal line brown; fringes fuscous; ventral surface of secondaries whitish, scantily pubescent basally; costally with heavy brown irroration,

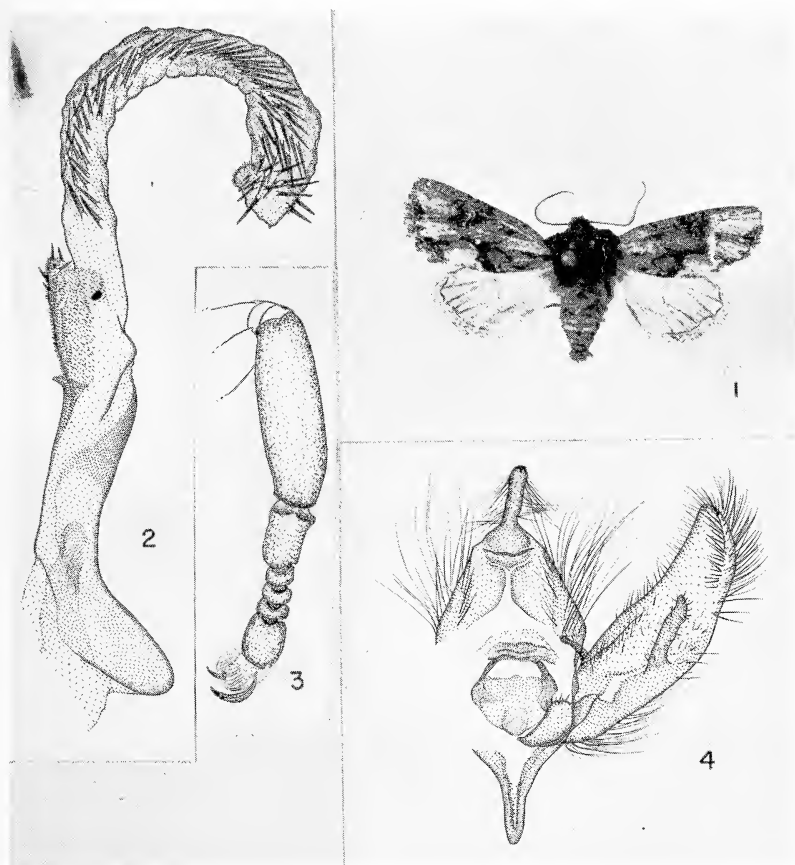


Fig. 1. Holotype male. Petaluma, Sonoma County, California, February 16, 1955 (J. S. Buckett).

Fig. 2. Aedeagus of *P. californica* Buckett and Bauer. Paratype male, Petaluma, Sonoma County, California, February 9, 1960 (J. S. Buckett), Bauer-Buckett slide number 63J19-21.

Fig. 3. Fore tibia and tarsus shown to illustrate enlarged first and last tarsal segments. Paratype male, Placerville, El Dorado County, California, March 15, 1964.

Fig. 4. Male genitalia of *Petaluma californica*, minus aedeagus. Data same as that of figure 2.

forming costal band; discal lunule brown; medial band brown, running parallel to outer margin, less irregular than on dorsal surface; terminal line brown, fringes whitish, irrorated with brown. Greatest expanse of fore wing 16 mm. Genitalia as in figures 2 and 4.

Holotype male: (deformed in the transverse posterior region of the right forewing) Petaluma, Sonoma County, California, February 16, 1955 (J. S. Buckett). Paratype male same locality as holotype, collected February 6, 1960 (J. S. Buckett), Bauer-Buckett slide number 63J19-21; eight male paratypes, Placerville, El Dorado County, California, March 15, 1964. Holotype male deposited in the Type Collection, Entomology Department, University of California, Davis. One male paratype is deposited in the Franclemont private collection, Cornell University, Ithaca, New York; one male paratype is also deposited in the United States National Museum, Washington, D. C. The remaining seven paratypes are retained in the collection of the authors. All specimens used in this paper are from the Bauer-Buckett Collection, Davis, California.

With a series of ten specimens before the authors, variation seems considerable, the color of the fore wings in different specimens is from that of the holotype to suffused dark brown.

We take great pleasure in naming this moth after the quaint community in which we were both members for a number of years.

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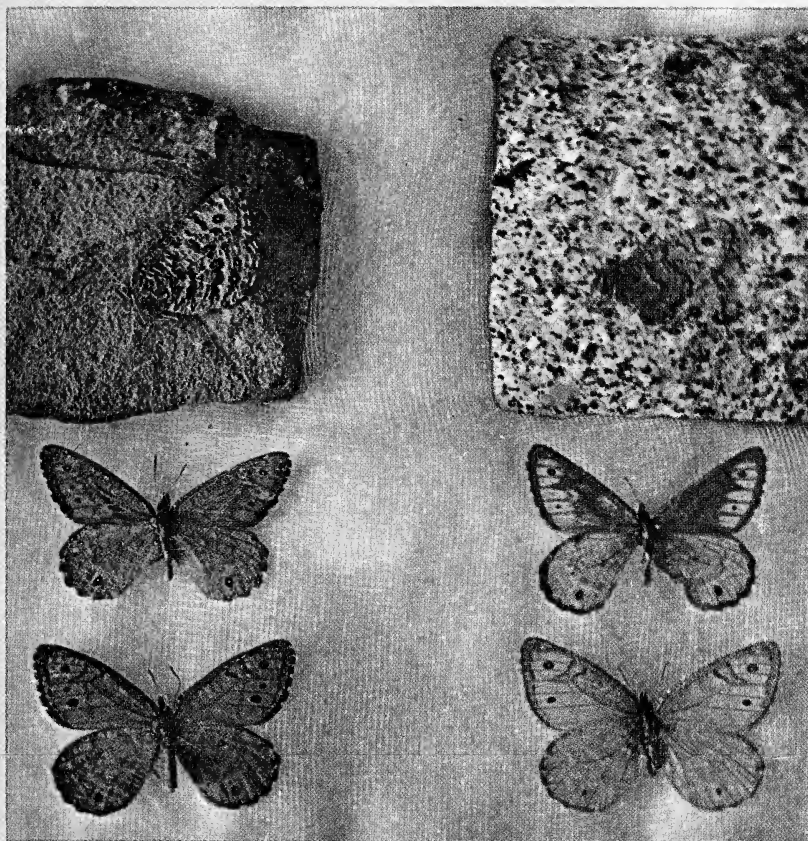
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LILLIAN LA DUE

5224 - 15 Ave., Sacramento, California

THE METABOLIC RATE OF AN ORGANISM can be estimated from (a) the food consumption, (b) the energy released as heat, or (c) the amount of oxygen used in oxidation processes to obtain the energy. All three methods can be employed, but they are not equally satisfactory. The first method is cumbersome and may give misleading information. The second method, heat production, is technically difficult to carry out, but is nevertheless the most accurate method of determining energy metabolism. The determination of oxygen consumption, the third method, however, is technically easy, gives good results, and, in fact has been used so much that when metabolic rate is mentioned, it usually means rate of oxygen consumption (Schmidt-Nielsen, 1961). The oxygen consumption method is also the most satisfactory method for determining the metabolic rate of pupae.

The function of the pupal stage of metamorphosis is that of structural reorganization. During this phase the metabolic rate falls during the early stages and rises during the latter part of the phase. The oxygen consumption and metabolic rate of the *Papilio zelicaon* pupae, to which moisture had been added, was done in an effort to gain some insight into the reasons for their remaining in the pupal stage for a longer period than is normal; those involved had been in the pupa stage for two years.

There are several factors which influence total metabolism in general; these include temperature, body size, ingestion of food, muscle work, and water. The hypothesis was that the addition of moisture would bring about an increase in the metabolic rate of the pupae thereby causing them to emerge, as it was thought that the reason for the delay was due to insufficient moisture taken in by the pupae during the larval stage.

In the determination of the metabolic rate of the pupae, the exact methods used were taken from those described by Schmidt-Nielsen (1961) in which he employs these methods for the



Fig. 1—Pupae incubation quarters between tests.

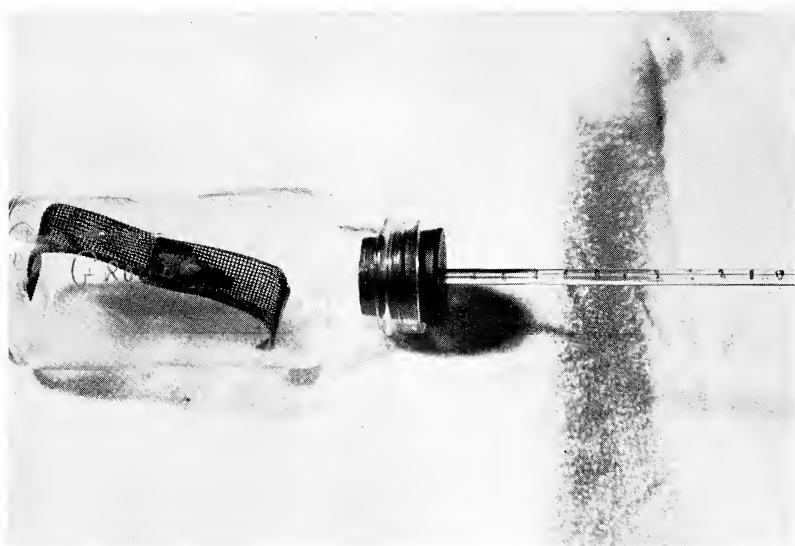


Fig. 2—Apparatus used for determination of oxygen consumption.

oxygen consumption in rats. Information on the methods and selection of experimental subjects was also obtained orally from Mr. Eugene Volz of Sacramento City College.

Information on the effects of moisture upon the eclosion of pupae was obtained from Folsom (1922). He also points out the importance of moisture upon the rate of metabolism in insects. Information was also gained on metabolism in relation to evaporation, and its effect of the eclosion of pupae.

MATERIALS AND METHODS

The pupae used were *Papilio zelicaon* collected as larvae from anise plants, their usual food plant, in Sacramento, California during the month of April 1961. They were kept on that diet during their larval stage. The larvae were raised under conditions other than normal in that they were kept indoors and no moisture was given other than that which was gained from eating the food plant.

The pupae were separated into five groups. These groups, which received moisture twice daily were; the positive control group—30 drops, test group A—15 drops, test group B—10 drops, test group C—5 drops, and the negative control which received no moisture. The moisture was applied directly to the pupae with a dropper pipette. During the time they were not being tested the pupae were kept on a table in an open box shown in fig. 1.

For the determination of oxygen consumption, a simple apparatus was used as appears in fig. 2. This equipment included the bottles, one-hole rubber stoppers, copper wire mesh, NaOH crystals and graduated pipettes.

The NaOH crystals, which were used to absorb the CO_2 expired from the pupae, were mixed with hot water to form a syrupy solution and then allowed to cool to room temperature before being poured into the bottles. The bottles were then placed in an insulated campers ice box to keep the temperature constant. A sheet of glass was then placed over the top of the box to ensure these conditions, and the readings were done through the glass. The temperature inside the box was 76 degrees F at all times.

The bottles were placed in a slanting position so that the solution of NaOH was held into one corner of the bottom of the bottle and the copper wire screen was placed in a position so as

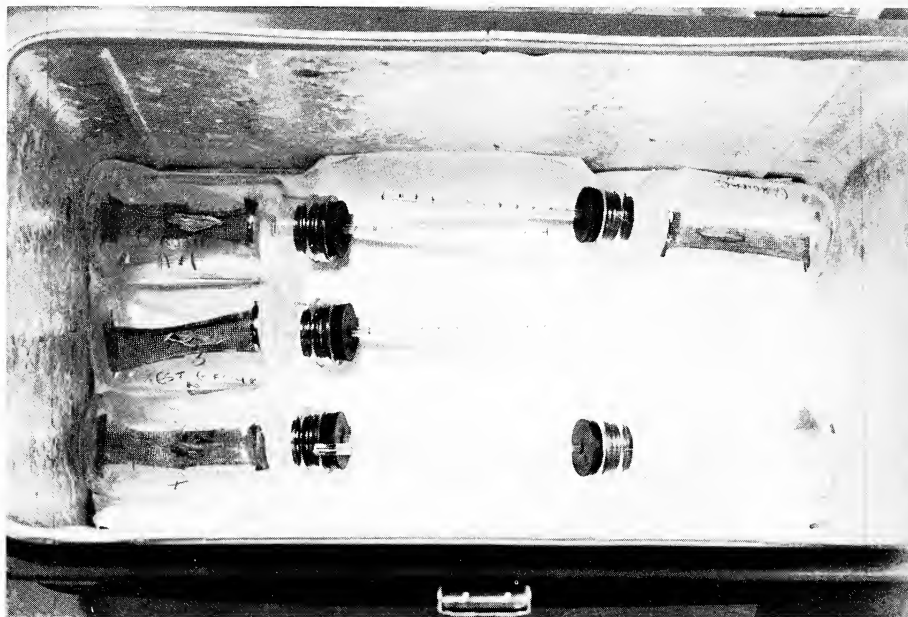
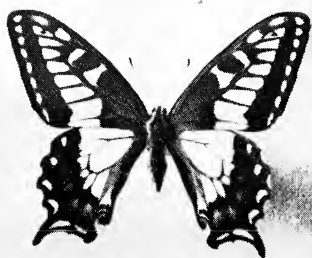


Fig. 3—Set up showing how bottles were arranged in a camper's box during determination of oxygen consumption for respiration rate evaluation.

normal

a



b

c

d



not to come into contact with the solution. The pupae were placed into the bottles and a period of time allowed to pass before the insertion of the drop of water into the end of the pipette. This was done to allow the temperature of the bottles to return to normal after being handled. A control bottle was also set up to determine if all conditions were correct. A movement in the bottle would have meant the tests were incorrect. To aid in the observation of the drop of water, red dye was added to the water which was inserted into the pipette. The set ups are shown in fig. 3.

Weighings of the pupae were done before and after the tests on an analytical balance, in milligrams.

RESULTS

When the larve which had been raised indoors pupated, the group that remained in the pupal stage long after the others had emerged were assumed to be dead. As the tests to determine the oxygen consumption were made on the pupae it was found that they were all alive and that with the addition of moisture, changes in the metabolic rate were taking place.

In table 1 the oxygen consumption per group for a period of one half hour in micro-liters is shown. Also shown is the percentage of moisture added daily per group. The oxygen consumed increased in proportion to the percentage of moisture added. The data in the table is shown in the graph, fig. 5, and shows the effects of moisture upon the metabolic rate of the groups according to the percentage of moisture added. The groups which received the greatest amount of moisture show a higher rate of oxygen consumption.

Table 2 shows the amount of oxygen and glucose consumed in micro-moles per group during a one half hour time period and also the number of calories released and the Adenosine Triphosphate (ATP) molecules formed during that time. Steady increases are also seen in the groups according to the data obtained.

Fig. 4—Deformed adults shown with a normal female.

- a) Group B No. 3—emerged V-15-63. Deformity is seen by holes present in both hindwings.
- b) Control group No. 2—emerged III-28-63. Deformity is not clear in photo, but the abdomen was not completely formed and was stuck to the pupal shell.
- c) Group B No. 1—emerged IV-29-63. The wings of the left side were not formed. Also note the small left antennae.
- d) Group C No. 1—emerged IV-14-63. Left wings were stuck to pupal shell and had to be pulled out. The abdomen is also small and short.

Table 1 - Oxygen consumption per group per one half hour in μ l and percentage of water added daily per group during experiments, shown in time in days.

Groups	water added per group daily	Time in Days - μ l O ₂ consumed				
		0	7	15	21	25
Control						
+	saturation	39	157	314	471	785
A	4	39	314	236	157	785
B	1.5	0	314	235	471	393
C	0.75	0	0	0	546	618
Control						
-	0	0	0	0	157	314

Table 2 - Total group data showing the amount of oxygen and glucose consumed, the number of calories released, and the ATP molecules formed during a one-half hour time period.

Group	μ l oxygen consumed per group for .5 hour	volume O ₂ consumed and quantity of glucose used up in μ moles	no. of calories released	no. of ATP molecules formed
Control				
+	352	14.3	9.81	25.9×10^{19}
A	306	12.5	8.62	22.5×10^{19}
B	283	11.1	7.65	20.5×10^{19}
C	233	9.5	6.56	17.5×10^{19}
Control				
-	94	3.8	3.78	10.3×10^{19}

The weighings of the pupa taken during the experiment are shown in Table 3, and show the weight loss per pupa as the metabolic rate increased due to the added moisture.

Five of the pupae emerged during the experiment, four of which are shown with a normal specimen in fig. 4. The fifth pupa was so deformed it could not completely break through the pupal shell, as the wings had not formed and were still attached to the shell. This pupa was from the positive control group. A sixth pupa, test group C No. 2, was dissected as it had shown a weight loss way below the others which had emerged and it was assumed that the pupa was parasited. When dissected, only the wings and part of the thorax remained, the rest was eaten away leaving an empty shell.

DISCUSSION

With the addition of moisture to the pupae it was shown that the rate of oxygen consumption increased according to the percentage of moisture added. This rise did not seem to be on a straight line however, with the group curves rising and falling, fig. 4. A reference from Rogers (1927) could perhaps give the reason for this fluctuation. "In the pupal stage the respiratory quotient (of *Bombyx mori*) has a value of 0.6 or less. The glucose present in the body is not all used in respiration but may be utilized in building imaginal tissue. Glucose is synthesized at first from protein but during the latter part of the pupal stage apparently from fat. The respiration curve falls during the early pupal stage and rises during the latter part of that stage". The oxygen consumption of the pupae was much higher as they approached the time of eclosion. The relationship of the loss of weight by the pupae and the time of eclosion was also shown. The pupae began to emerge when the body weight was down in the area of 670-770 mg. as shown in Table 3.

That the addition of moisture to the pupa brought about a rise in metabolism which resulted in the eclosion of the adult butterfly, which is also the hypothesis, would seem to be true. The emergence of a pupa from the negative control group, which received no moisture, tends to disprove the hypothesis. The thought that the temperature might have had a part in this was brought to mind although the pupae had been kept at room temperature for the two year period. Also to be considered was the humidity and perhaps the amount of moisture and nutrition which had been taken in by the pupa during the larve stage. That temperature is important in the eclosion of pupae is known and Biliotti (1953) has shown with various temperatures the pupae in a state of delayed eclosion were made to emerge .

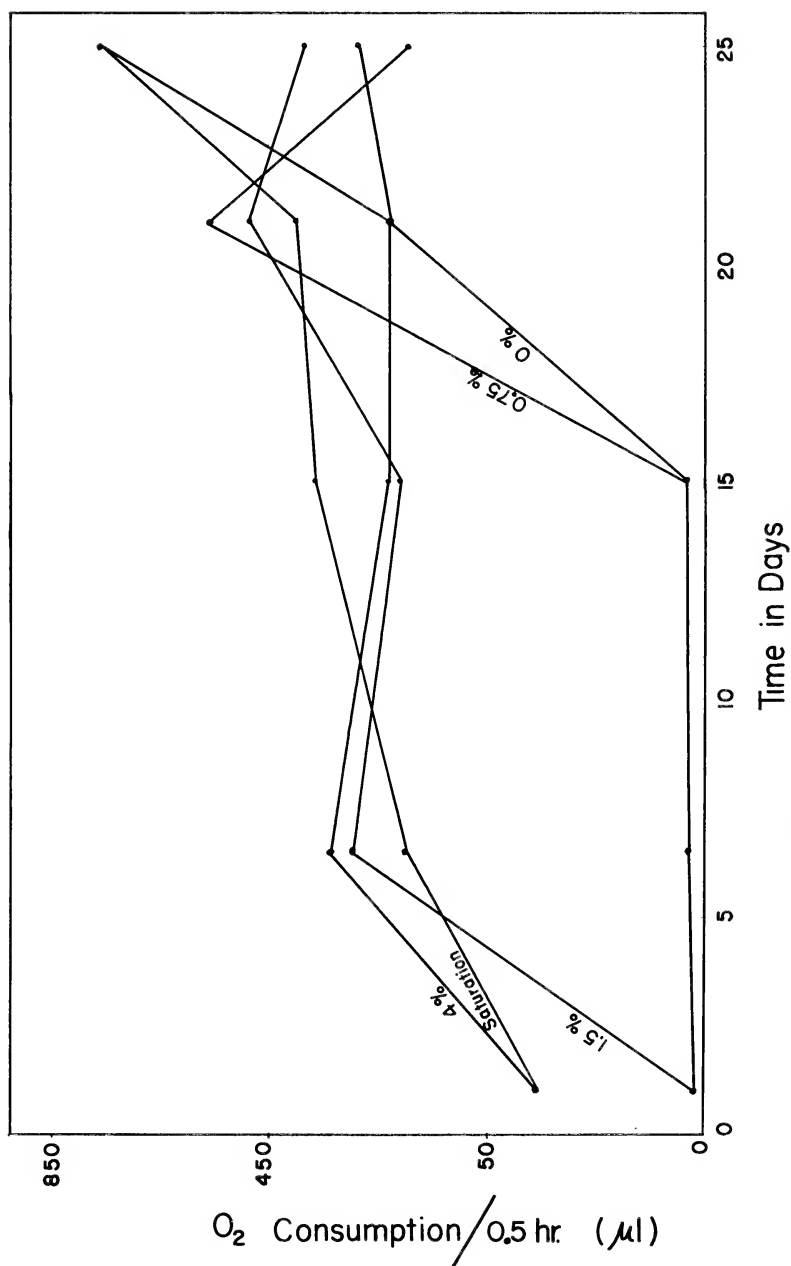


Fig. 5—Effects of moisture upon the metabolic rate per group.

Table 3. Weight of pupae before and after tests, showing the loss in weight in milligrams as the metabolic rate increased.

Pupa Control	Time in Days				
Group					
+	0	9	17	23	25
1	860	820	800	700	670
2	870	850	800	800	800
3	940	900	900	900	870
Group A					
1	1060	1000	1000	950	950
2	1020	900	870	870	870
3	1000	1000	890	850	850
Group B					
1	900	870	760		
2	850	800	800	750	750
3	1060	870	800	800	770
Group C					
1	900	850			
2	1000	550	350	300	250
3	900	900	800	750	750
Control —					
1	780				
2	860	850	800	800	800

Eclosion of pupa

Moisture ranks with temperature as a highly essential condition of existence and plays an important part in growth. That moisture is important to the eclosion of pupae is stated by Folsom (1922) "Moisture frequently determines the time of eclosion, or the emergence of an insect from the pupa. Hessian flies do emerge from the puparia in dry weather, but issue in abundance after rainfall in the proper season. When bred indoors, the flies do not emerge from dry soil, even though the temperature be favourable, but emerge shortly when the soil is moistened". He also states that when raising moths from pupae that the pupae must have a certain amount of moisture or they will dry out and die. In comparing this with the results of the experiment it would seem to support the hypothesis.

That the adult butterflies were deformed when they emerged may be the reason they did not emerge at the normal time. It can only be assumed that during the larval stage they did not receive adequate nutrition and moisture to allow them to develop normally and that with the moisture applied they were able to complete the pupal cycle but that the delayed eclosion caused the deformities. Since only five out of the groups have emerged at the time of this writing it is too soon to reach a conclusion on this.

CONCLUSION

The results of the tests made on the oxygen consumption and metabolic rate of the pupae have shown that with the addition of moisture, the metabolic rate of the groups of pupae was raised, and resulted in the eclosion of the adult butterfly. It was also shown that the amount of oxygen consumed was appreciably influenced by the percentage of water added per group. The group receiving the most moisture consumed the most oxygen; this corresponds to a greater number of calories released and the formation of the greater number of ATP molecules.

"The author wishes to express her appreciation to her husband, Noel La Due, for his photography and assistance with the study. Appreciation is also expressed to Mr. Jacques Ricard of Sacramento City College for his help and advice during the entire study."

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LIFE HISTORY STUDIES ON MEXICAN BUTTERFLIES

III. NINE RHOPALOCERA (PAPILIONIDAE, NYMPHALIDAE, LYCAENIDAE) FROM OCOTAL CHICO, VERACRUZ

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OCOTAL CHICO (meaning "small pine ridge") is a small Popoluca Indian village in southern Veracruz, Mexico, and in the eastern section of the Sierra Tuxtla. The village is situated at an elevation of 1900 feet above sea level and on one of several ridges that radiate down the leeward slope of Volcán Santa Marta, the second highest peak in the Tuxtlas (elevation 5100 ft.). This volcano is presently inactive and is covered with virgin rain forest. The actual crater is surrounded by "elfín" forest. The lower ridges, however, are covered with tall stands of pine (*Pinus oocarpa* Schiede) and some oak (*Quercus* spp.). These ridges slope (sometimes very steeply) down to small, clear streams; the vegetation on them becomes increasingly richer in hardwoods so that the actual streams are bordered by dense stands of secondary rain forest.

In the summer of 1963, I spent three months at Ocotál Chico collecting on the slopes of Volcán Santa Marta. During that period, I was able to rear the immatures of nine species of butterflies: *Parides photinus* (Doubleday), *Papilio thoas autoctes* Rothschild & Jordan, *Heliconius petiveranus* Doubleday, *Eueides cleobaea zorcaon* (Reakirt), *Dryas julia delila* (Fabricius), *Euptoietia hegesia hoffmanni* W. P. Comstock, *Chlosyne janais* (Drury), *Eumaeus minyas* Hübner, and *Eumaeus debora* Hübner. Since the life histories of three of these species (*P. photinus*, *H. petiveranus*, and *E. minyas*) have not been reported previously, and references to the immatures of the remaining species are often incomplete and inaccessible to most North American workers, I am presenting detailed descriptions.

Terminology is based on that of Fracker (1925) and Peterson (1948).

All drawings and photographs are by the author. All measurements are based on living material (larval measurements are based on specimens in a state of rest).

All preserved material is in the author's personal collection.

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FAMILY PAPILIONIDAE

Parides photinus Doubleday

The life history of this species has not been reported previously in the literature.

EGG: Fig. 1A. (Measurements and durations are based on 7 specimens.) Height (excluding pedicel), 2.4-2.5 mm.; width, 2.2-2.4 mm. Duration of stage, 6-7 days.

Spherical with 14-15 irregular ridges radiating from micropyle. Numerous circular-oblong elevations on surface. Egg attached to an oblong, ridged, pedicel concolorous with egg.

Color brownish orange, acquiring a purple tinge the day prior to larval emergence. Eggs are deposited singly on the undersurfaces of the leaves of *Aristolochia asclepiadifolia* T.S. Brandegee (Aristolochiaceae). I found this vine growing only at one locality on the outskirts of the village.

FIRST INSTAR LARVA: Fig. 2A. (Measurements and duration are based on 6 specimens) Beginning of stadium-length, 3.2-3.4 mm.; maximum width, 0.9-1.1 mm.; head diameter, 0.7-0.8 mm. Termination of stadium-length, 6.5-6.7 mm.; max. width, 1.8-1.9 mm. Duration, 4 days.

Head (fig. 5A) black with several tiny, fine, simple setae. Ocelli brown.

Body expanded slightly in anterior portion. Segments with paired, simple, black setae and paired scoli with black spinules (all scoli concolorous with ground color except when mentioned otherwise): prothoracic-2 dorsal setae (1 anterior, 1 posterior), 1 subdorsal seta (post.), 1 supraspiracular scoli, 1 spiracular scoli; mesothoracic-1 dorsal seta, 1 subdorsal scoli with spines forked at tips, 1 lateral seta with a forked tip, 1 supraspiracular scoli with spines forked at tips, 1 subspiracular scoli; metathoracic-1 subdorsal scoli with spines forked at tips, 1 lateral seta, 1 supraspiracular scoli with spines forked at tips, 1 subspiracular scoli; first through eighth abdominal-1 subdorsal scoli (red on first, second, third, fifth, sixth, and eighth segments) with spines forked at tips, 1 lateral seta with a forked tip, 1 supraspiracular scoli (red on same segments innumeralated above), 1 subspiracular scoli (red as the above); ninth abdominal-1 subdorsal scoli, 1 supraspiracular seta, 1 subspiracular seta; tenth abdominal-1 subdorsal scoli. Suprapedal lobes on all segments with 2 setae arising from verucca.

Ground color orangish red. Single, small, cream saddle on latero-posterior section of third abdominal segment and on lateroanterior section of fourth abdominal segment. Legs with claws black; prolegs concolorous with ground color. Spiracles brown. Osmateria yellow.

SECOND INSTAR LARVA: (Measurements and duration are based on 6 specimens.) Beginning of stadium-length, 6.9-7.2 mm.; width, 1.0-1.4 mm.; head diameter, 1.1 mm. Termination of stadium-length, 9.9-10.6 mm.; width, 2.9-3.5 mm. Duration, 4 days.

Head as before.

Body shape as before. Segments with paired setae and scoli as before unless otherwise mentioned: prothoracic-cervical shield with 2 dorsal setae, 1 subdorsal seta, 1 supraspiracular scoli (black), remainder of segment with 1 spiracular scoli (red); mesothoracic-1 subdorsal scoli (red with tinge of orange), 1 supraspiracular scoli (red); metathoracic-1 subdorsal scoli (red with tinge of orange), 1 supraspiracular scoli (red), 1 subspiracular scoli (red); first abdominal-1 subdorsal scoli, 1 supraspiracular scoli (red), 1 subspiracular scoli (red); second through eighth abdominal-1 subdorsal scoli (red on second, third, fifth, sixth, and eighth segments), 1 supraspiracular seta, 1 subspiracular scoli (red on second, fourth, fifth, sixth, and eighth segments); caudal (fused ninth and tenth segments)-subdorsal scoli now reduced to small "knobs", otherwise, the same as before. No setae are forked.

Ground color redder than before. Saddle more evident than before. Legs, prolegs, spiracles, and osmateria as before.

THIRD INSTAR LARVA: (Measurements and duration are based on 4 specimens.) Beginning of stadium-length, 11.0-12.0 mm.; width, 3.1-3.8 mm.; head diameter, 2.1-2.2 mm. Termination of stadium-length, 13.6-15.9 mm.; width, 3.7-4.9 mm. Duration, 6-7 days.

Head as before.

Body shape as before. Cervical shield with numerous setae arising from pinacula. Setae and pinacula. Setae and scoli on all other segments in the same arrangements as before. Scoli are now very stout and fleshy and the spines are now very much shorter and confined to the terminal portions of the scoli. All scoli now red with the following exceptions (which are cream with a light orange tinge): supraspiracular on third abdominal segment, subdorsal and subspiracular on seventh abdominal segment. Dense, fine, short, black setae on all segments (these appear as hairs).

Ground color velvety red with a slight orange tinge. Saddle as before. Legs, prolegs, spiracles, and osmateria as before.

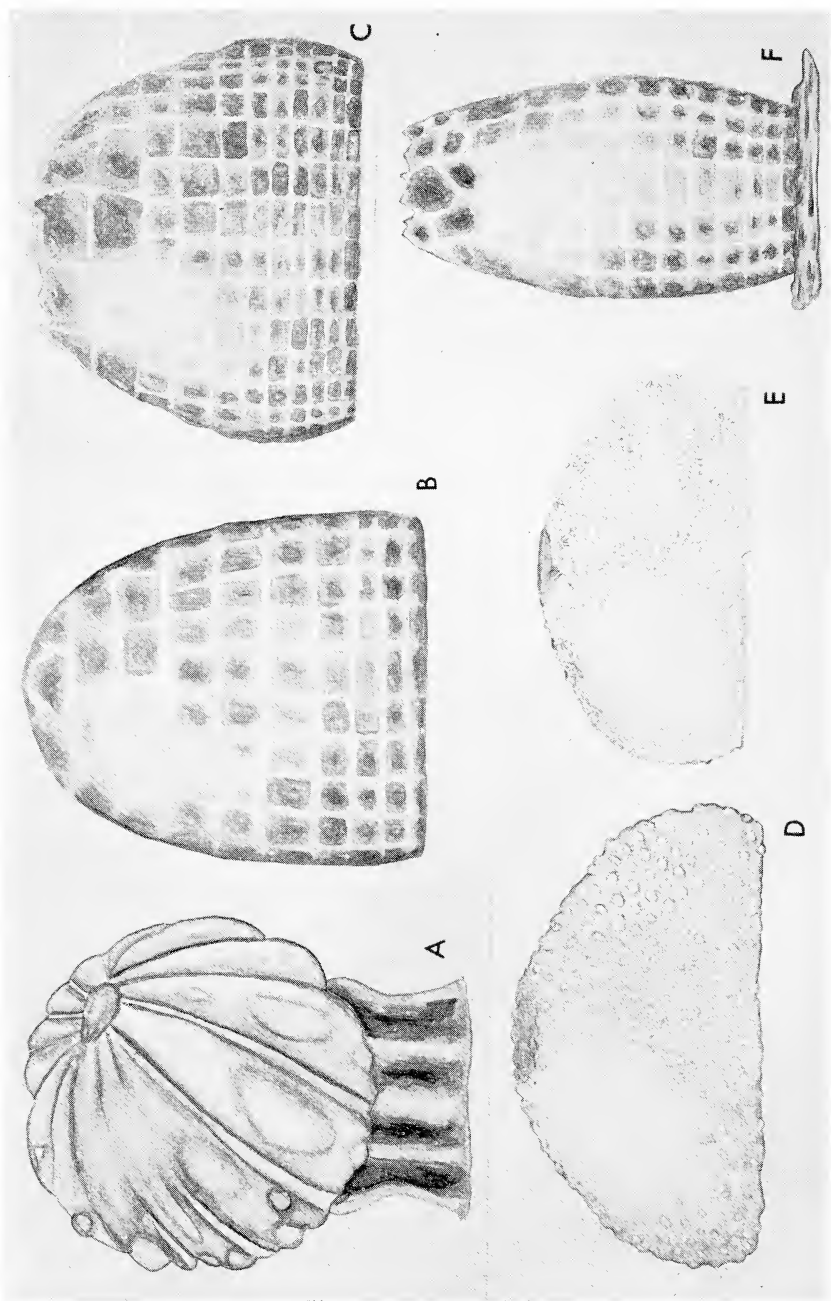


Fig. 1. Eggs of: A. *Parides photinus* D.; B. *Eueides cleobaea zorcaon* R.; C. *Euptoieta hegesia hoffmanni* W.P.C.; D. *Eumaeus minyas* H.; E. *Eumaeus debora* H.; F. *Heliconius petiveranus* D.

FOURTH INSTAR LARVA: (Measurements and duration are based on 3 specimens.) Beginning of stadium-length, 14.0-15.2 mm.; width, 4.1-4.9 mm.; head diameter 2.8-3.0 mm. Termination of stadium-length, 18.6-19.9 mm.; width, 4.4-5.0 mm. Duration, 6-7 days.

Head as before.

Body shape as before. Setae and scoli in same arrangement as before. The pair of supra-spiracular scoli on the prothoracic segment and the pair of subdorsal scoli on the first abdominal segment are now greatly reduced. Scoli with same colors as before with the following exception: the subdorsal on the fourth abdominal segment is now red. Sparse, simple, small, black setae or hairs scattered irregularly on all segments.

Ground color dark reddish black with saddle very conspicuous. Legs, prolegs, spiracles, and osmateria as before.

FIFTH INSTAR LARVA: (Measurements and duration are based on 3 specimens.) Beginning of stadium-length, 19.1-21.7 mm.; width, 4.8-5.7 mm.; head diameter, 3.7-4.0 mm. Termination of stadium-length, 27.7-30.3 mm.; width, 6.6-8.0 mm. Duration, 7-8 days.

There is no deviation from the previous stage except that the ground color is now velvety black with only a tinge of red showing up on the suprapedal lobes.

SIXTH INSTAR LARVA: Fig. 2B. (Measurements and duration are based on 2 specimens.) Beginning of stadium-length, 32.1-34.2 mm.; width, 8.7-9.9 mm.; head diameter, 4.5 mm. Termination of stadium-length, 47.1-51.9 mm.; width, 12.0-14.6 mm. Duration, 9-10 days.

Head with more setae than before (fig. 5B).

There is no significant deviation from the previous stage except that the reddish tinge on the suprapedal lobes is now less evident. Fig. 2B illustrates a mature larva.

Three days prior to pupation, the larva attaches the caudal end to the substrate and spins a silken girdle around the thoracic region of the body.

PUPA: Fig. 6A. (Measurements and duration are based on 1 specimen.) Length, 33.6 mm.; maximum width, 17.4 mm. Duration of stage, 17 days.

Head portion with two small dorsal horns protruding anteriorly. Antennae extending slightly beyond wing margins. Proboscis slightly shorter than wing cases.

Body with first three abdominal segments greatly expanded laterally in the typical *Battus*-*Parides* form. Also, third through sixth abdominal segments each with a pair of dorsal keels. Cremaster with numerous black hooks. There is a thoracic girdle.

Ground color a dull light green except dorsal surface which is chartreuse.

IMAGO: Fig. 8D. Adults were common in and around the borders of the tropical forests, never in the pine woods. This species was one of the few species of papilionid that I took regularly in the virgin rain forests on the upper slopes of the volcano. In that environment, oviposition was probably on something other than *Aristolochia asclepiadifolia* for I failed to observe that plant growing there.

Hoffmann (1940) gives the Mexican range of this species as the warm and hot regions of the two coasts, the Rio Balsas Valley, Michoacan, Jalisco, and Chiapas.

Papilio thoas autocles Rothschild and Jordan

There are several references in the literature regarding the immature stages and food plants of this species. However, most of these refer to the South American subspecies *P. t. thoas* L. The references are: Burmeister (1878)-description and illustrations of a larva and pupa, records larval food plant as *Piper citrifolium* Lam.; Comstock and Vazquez (1961)-descriptions and illustrations of a larva and pupa, records *Citrus* (lemon) and *Piper* sp. as larval food plants; Ehrlich (1961)-records *Citrus* as the larval food plant; Fassi (1909)-brief mention of ovum; Hoffmann (1937)-brief description of ovum, early and late instar larvae, and records orange as the larval food plant; Holland (1931)-records *Ptelea*, *Xanthoxylon*, and *Citrus* as larval food plants; Jones (1882)-brief mention of larva and pupa, records orange as the larval food plant; Moss (1919)-brief mention of egg, early and late instar larva, illustrations of fourth, fifth instar larva and pupa, and records orange, lemon, *Piper aduncum*, *Piper belemense* as the larval food plants.

FIRST INSTAR LARVA: Fig. 2D. (Measurements and duration are based on 3 specimens.) Beginning of stadium-length, 2.8-2.9 mm.; maximum width, 0.8-0.9 mm.; head diameter, 0.9 mm. Termination of stadium-length, 5.5-5.7 mm.; maximum width, 1.7-1.9 mm. Duration, 4-5 days.

Head (fig. 5E) coffee brown with numerous black, simple setae arising from small chalazae.

Body expanded anteriorly (thoracic segments and first abdominal segment) into a "false head";

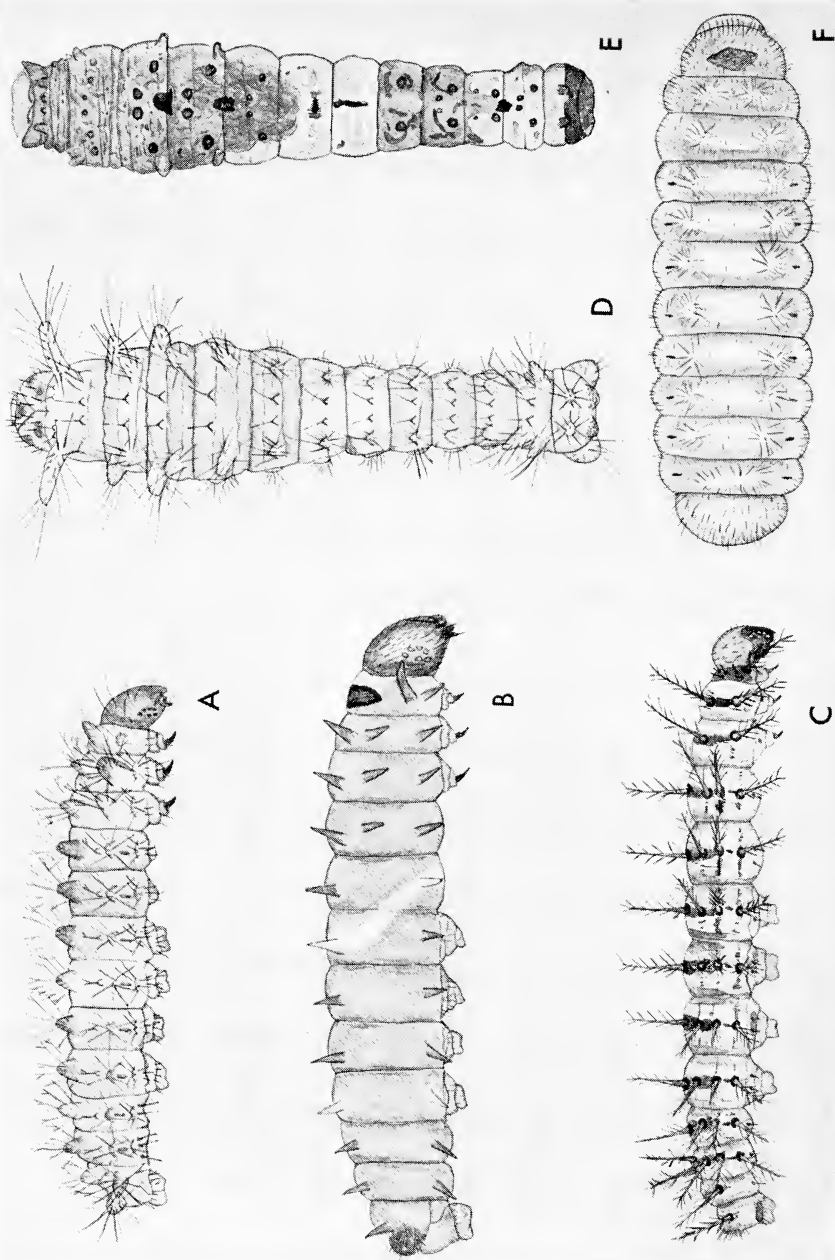


Fig. 2. Larvae: A, 1st instar and B, 6th instar of *Parides photinus* D.; C, Last instar of *Chlosyne janais* D.; 1st instar and E, 3rd instar of *P. thoas autocles* R. and J., F, 4th instar of *Eumaeus debora* H.

the eighth and ninth abdominal segments expanded very slightly, too. Segments with paired simple, black setae and paired scole with black spinules (all scole concolorous with ground color except when otherwise mentioned): all segments with 1 dorsal seta; prothoracic-1 subdorsal scolus, 1 lateral scolus (long), 1 spiracular-subspiracular scolus; meso- and meta-thoracic-1 subdorsal scolus, 1 lateral scolus (shorter than on previous segment), 1 subspiracular scolus; abdominal-1 subdorsal scolus (large and posterior on eighth segment, large and anterior on ninth segment, thus giving the appearance of a forked scolus), 1 supraspiracular scolus, 1 subspiracular scolus; caudal-suranal plate with numerous short setae; suprapedal lobes with several setae.

Ground color glossy, coffee brown. Two cream saddles: one on portions of second, third, and fourth abdominal segments and one on portions of seventh, eighth, and ninth abdominal segments. Venter bluish grey. Legs dark brown; prolegs bluish grey. Spiracles inconspicuous. Osmateria reddish orange.

Newly hatched larvae were found on the upper surfaces of the leaves of both *Piper marginatum* Jacq. and *Piper kerberi* C. DC. (Piperaceae). These plants were common along the shaded stream banks and in the tropical forests on the slopes above the streams. It is interesting to note that when larvae taken on *P. marginatum* were offered leaves of *P. kerberi*, they accepted them without any hesitancy. The reciprocal cross worked equally as well.

(The first molt was missed accidentally.)

THIRD INSTAR LARVA: Fig. 2E. (Measurements and duration are based on 3 specimens.) Beginning of stadium- length, 13.0-13.6 mm.; maximum width, 3.6-3.8 mm.; head diameter, 2.3-2.4 mm. Termination of stadium- length, 19.5-20.6 mm.; max. width, 5.7-6.4 mm. Duration, 5 days.

Head (fig. 5F) coffee brown with dense, fine, simple, tan setae.

Body shape as before. All setae as before but very inconspicuous. All scole now reduced to small rounded knobs topped with fine, tan, simple setae. Supraspiracular scole on abdominal segments and spiracular and subspiracular acole on all segments now entirely absent. The lateral pairs on the prothoracic segment are still the most prominent scole.

Ground color browner than before but still glossy. Dorsal and ventral surfaces with numerous white-grey-cream irregularly shaped blotches and lines giving the larvae a mottled appearance and a remarkable resemblance to bird excrement. Small, light blue dots dorsal to the above mentioned knobs and ventral to the spiracles. Cream saddles now very evident. Legs, prolegs, spiracles, and osmateria as before.

FOURTH INSTAR LARVA: (Measurements and duration are based on 2 specimens.) Beginning of stadium- length, 22.0-23.2 mm.; maximum width, 7.3-7.9 mm.; head diameter, 3.0-3.5 mm. Termination of stadium- length, 27.0-28.9 mm.; max. width, 7.3-7.9 mm. Duration, 6 days.

Head as before.

Body as before except that the light markings on the dorsal and lateral surfaces are now more extensive.

FIFTH INSTAR LARVA: (Measurements and duration are based on 2 specimens.) Beginning of stadium- length, 33.1-34.3 mm.; maximum width, 8.0-9.1 mm.; head diameter, 4.1-4.3 mm. Termination of stadium- length, 51.2-55.6 mm.; max. width, 10.2-12.1 mm. Duration, 9 days.

This stage is illustrated by Comstock and Vazquez (1961) and my two specimens showed no deviation from their description. It is interesting to note here that after the fourth molt, the larvae lost their glossy appearance, the integument taking on a dry, wrinkled look.

PUPA: Measurements and duration are based on 2 specimens.) Length, 34.2-35.1 mm.; maximum width, 10.6-11.9 mm. Duration of stage, 10 days.

This stage is illustrated by Comstock and Vazquez (1961), also. My two specimens showed no deviation from their description and I did not make any sketches in the field.

IMAGO: Fig. 8, A, B. Adults were common in the open, sunny areas in and around the village. I frequently observed them sipping moisture from damp areas in the mud.

Ehrlich (1961) lists the range of this species as Florida, southern Texas to Argentina. Hoffmann (1940) records the Mexican subspecies *autocles* as occurring in the warm regions of both coasts.

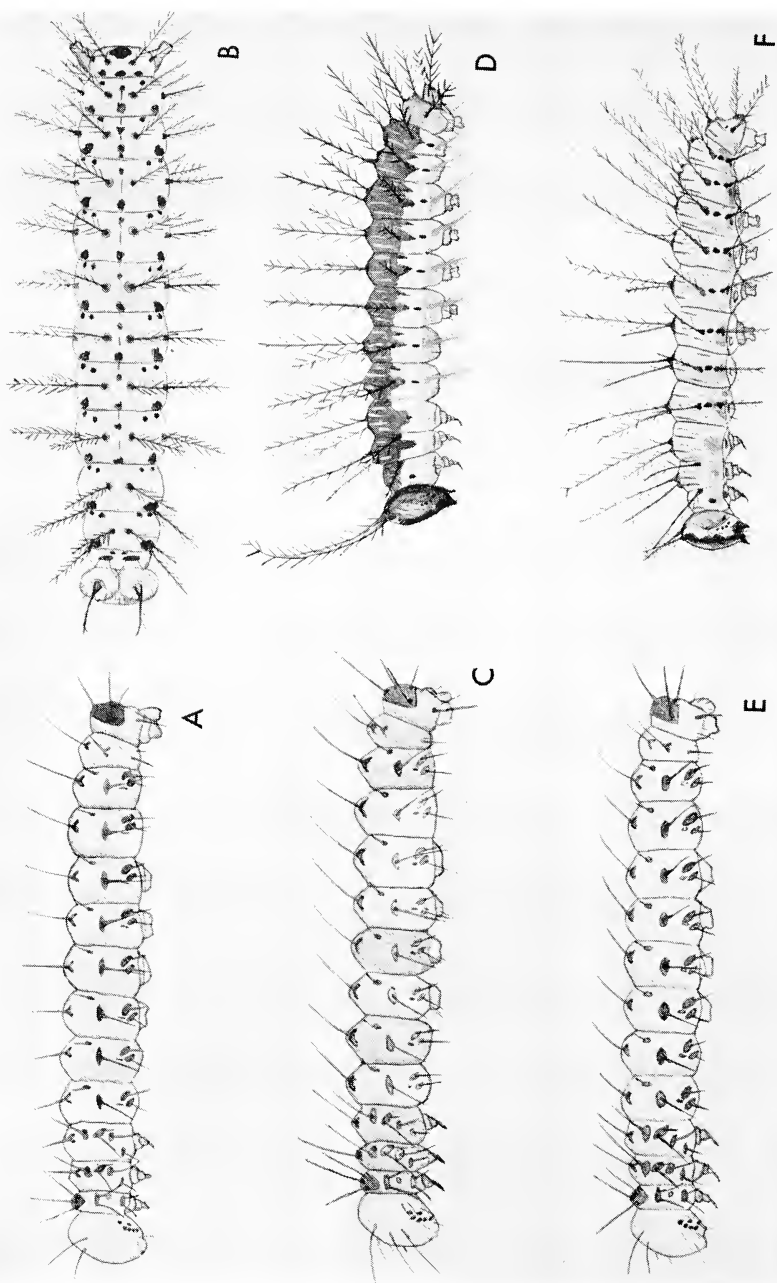


Fig. 3. Larvae: *Heliconius petiveranus* D., A. 1st instar, B. 5th instar; *Eueides cleobaea* zorcaon R, C. 1st instar, D. 5th instar; *Dryas julia delila* F, E. 1st instar, F. 5th instar.

FAMILY NYMPHALIDAE

Heliconius petiveranus Doubleday

The life history of this species has not been reported previously in the literature. Ehrlich (1961) records *Passiflora* sp. as the larval food plant.

EGG: Fig. 1F. (Measurements and duration are based on 5 specimens.) Height, 1, 4-1, 5 mm.; width, 0, 8-0, 9 mm. Duration of stage, 4 days.

Cylindrical in shape. Entire outer surface composed of rectangular reticulations, these less numerous near the micropyle. Micropyle surrounded by an irregular ridge.

Color bright yellow turning orange the day prior to larval hatching.

Eggs are deposited on the undersurfaces of the leaves or on the new tendrils of *Passiflora biflora* Lam. (Passifloraceae), a small vine which grew commonly on the ridge slopes in the deciduous forests. It is interesting to note that while collecting in the vicinity of Laguna Catemaco for a few days in late August of the same year, I noticed females of this species ovipositing both on *P. biflora* and *P. coriacea* Juss. The latter grew in and around the margins of the secondary forests. This area has been discussed in a previous paper (Ross, 1964).

FIRST LARVAL INSTAR: Fig. 3A. (Measurements and duration are based on 2 specimens.) Beginning of stadium-length, 3, 1-3, 2 mm.; width, 0, 3-0, 4 mm.; head diameter, 0, 3 mm. Termination of stadium-length, 4, 5-4, 6 mm.; width, 0, 8-0, 9 mm. Duration, 2 days.

Head (fig. 5C) tannish yellow with numerous small, simple, black setae (the pair on the apex slightly longer than the others).

Body cylindrical. Segments with paired, simple, black setae: prothoracic- cervical shield with 3 arranged in a triangular pattern, 2 supraspiracular, 2 spiracular; meso- and metathoracic- 1 dorsal, 1 subdorsal, 2 supraspiracular, 1 spiracular; first through eighth abdominal- 1 dorsal, 1 subdorsal (posterior), 1 supraspiracular, 2 subspiracular; ninth abdominal- 1 dorsal, 1 subdorsal, 1 supraspiracular, 1 subspiracular (very short); caudal- suranal plate with 3 long and numerous short setae; suprapedal lobes with setae: 2 on prothoracic and fifth abdominal segments, 1 on all other segments.

Ground color yellowish tan, the thoracic and first abdominal segments slightly more yellowish than the remaining segments. Legs and prolegs concolorous with ground color. Spiracles dark brown.

Larvae consume shells after hatching.

SECOND INSTAR LARVA: (Measurements and duration are based on 2 specimens.) Beginning of stadium-length, 5, 1-5, 4 mm.; width, 0, 9-1, 2 mm.; head diameter, 1, 0-1, 1 mm. Termination of stadium-length, 7, 0-7, 4 mm.; width, 1, 6-2, 0 mm. Duration, 3 days.

Head tannish orange with setae as before except apical pair is now replaced by a pair of spiny, black scale, 0, 9 mm. in length.

Body shape as before. Segments with paired, simple, black setae and apical black scale with spinules: prothoracic- cervical shield divided so that there are 3 distinct setae, per half, remainder of segment with 2 supraspiracular setae, 2 spiracular setae, 1 supraspiracular scolus at juncture of pro- and mesothoracic segments; mesothoracic- 1 dorsal-subdorsal scolus, 2 supraspiracular setae, 1 scolus at juncture of meso- and metathoracic segments; metathoracic- 1 dorsal-subdorsal scolus, 2 supraspiracular setae; first through eighth abdominal- 1 dorsal-subdorsal scolus, 1 supraspiracular scolus, 1 subspiracular scolus; ninth abdominal- 1 dorsal-subdorsal scolus, 1 supraspiracular seta, caudal- 1 dorsal seta, 1 supraspiracular scolus, 3 subdorsal setae, suranal plate with numerous setae; suprapedal lobes with numerous setae.

Ground color tannish orange. Legs black; prolegs concolorous with ground color. Spiracles brown.

THIRD INSTAR LARVA: (Measurements and duration are based on 1 specimen.) Beginning of stadium-length, 8, 1-8, 4 mm.; width, 1, 2-1, 4 mm.; head diameter, 1, 6-1, 8 mm. Termination of stadium-length, 15, 5-15, 9 mm.; width, 2, 1-2, 7 mm. Duration, 4 days.

Head light tan. Paired apical scale slightly larger than before. A pair of rectangular, black patches on median section of frontals and contiguous with the epistomal suture. Ocelli black and set in a black field.

Body shape and with setae and scale as before.

Ground color pale grey with a slight yellow tinge. Segmental junctures pale green. A narrow middorsal greenish-grey band with 2 black, triangular dots per segment (1 anterior, 1 posterior) on all segments except the eighth, ninth, and tenth abdominal. Segments with 1-2 faint, black dots in subdorsal and supraspiracular regions. Legs and prolegs as before. Spiracles black.

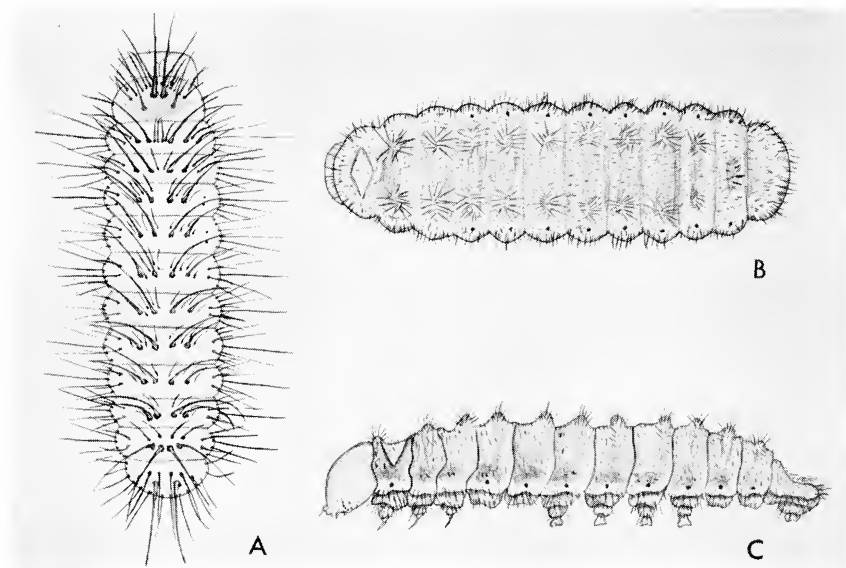


Fig. 4. Larvae: *Eumaeus minyas* H., A. 1st instar, B. and C. 4th instar.

FOURTH INSTAR LARVA: (Measurements and duration are based on 1 specimen.) Beginning of stadium-length, 16.5 mm.; width, 2.5 mm.; head diameter, 2.4 mm. Termination of stadium-length, 20.9 mm.; width, 3.5 mm. Duration, 4 days.

Head as before but pair of apical scole slightly longer.

Body shape and with setae and scole as before.

Ground color as before. Middorsal band now yellowish orange, wider and less defined than previously. Black dots slightly more distinct. A lateral, discontinuous, longitudinal, pale white band faintly evident. Legs, prolegs, and spiracles as before.

FIFTH INSTAR LARVA: Fig. 3B. (Measurements and duration are based on 1 specimen.) Beginning of stadium-length, 22.0 mm.; width, 3.8 mm.; head diameter, 3.4 mm. Termination of stadium-length, 26.1 mm.; width, 4.2 mm. Duration, 5 days.

Head (fig. 5D) pale, greyish white with black markings on frontals now larger and more conspicuous. Pair of apical scole now 2.0 mm. in length.

Body shape and with setae and scole as before.

Ground color as before. Dorsal band now expanded laterally and contiguous with lateral, white band. Paired black dots now distinct and on all segments in the following arrangement: prothoracic-1 dorsal; mesothoracic through eighth abdominal-1 large anterior supraspiracular, 1 small posterior subdorsal, and 1 small posterior supraspiracular; caudal (fused ninth and tenth segments)-1 anterior supraspiracular. Bases of dorsal-subdorsal scole with light orange rings.

Two days prior to pupation, the larva attaches the caudal segment to a substrate and hangs suspended head downward. Unfortunately, my one larva accidentally was knocked loose and killed. Hence, I do not have a description of the pupal stage.

IMAGO: Fig. 8, C. Adults were abundant in the general vicinity of the village along the margins of the secondary forests and along the margins of small thickets. They did not occur in the virgin rain forest.

Ehrlich (1961) gives the range of this species as "southern Texas, southward". Hoffmann (1940) records the species as occurring in the warm and hot coastal regions of southern Mexico and Yucatan.

Eueides cleobaea zorcaon (Reakirt)

Four authors have made reference to the immature stages and/or larval food plants of this species--Fassl (1909), brief mention of an egg, and a larva; Seitz (1924)- description of egg, larva (of genus only), pupa, and records *Passiflora* sp. as the larval food plant; Wolcott (1923)- records *Passiflora* sp. as the larval food plant; Wolcott (1936)- records *Passiflora* sp. as the larval food plant.

EGG. Fig. 1B. (Measurements and duration are based on 6 specimens.) Height, 0.8-0.9 mm. Duration of stage, 5 days.

Conical in shape. Outer surface composed of rectangular reticulations, these less numerous near the micropyle.

Color light yellow.

Eggs are deposited on the undersurfaces of the leaves or on the new tendrils of *Passiflora ambigua* Hemsl. (*Passifloraceae*), a vine which grew commonly on many of the fences in the village and on some of the shrubs and trees on the outskirts of the village. The Popolucas say that the fruit of this plant is very tasty.

While collecting near Laguna Catemaco (see under *H. petiveranus*), I noticed females of this butterfly ovipositing on *P. serratifolia* L. exclusively (I did not see *P. ambigua* growing there).

FIRST INSTAR LARVA: Fig. 3C. (Measurements and duration are based on 5 specimens.) Beginning of stadium- length, 1.8-1.9 mm.; width, 0.1-0.2 mm.; head diameter, 0.3 mm. Termination of stadium- length, 3.4-3.5 mm.; width, 0.5-0.6 mm. Duration, 4-5 days.

Head (fig. 5K) black with a pair of dorsal tan patches. Numerous fine, simple, black setae on all surfaces (one pair on apex slightly longer than the others).

Body cylindrical. Segments with paired, simple, black setae: prothoracic- cervical shield with 3 arranged in a triangular pattern, 2 supraspiracular, 2 spiracular; meso- and metathoracic- 1 dorsal, 1 subdorsal, 2 supraspiracular, 1 spiracular; first through eighth abdominal- 1 dorsal, 1 subdorsal (posterior), 1 supraspiracular, 2 subspiracular; ninth abdominal- 1 dorsal, 1 subdorsal, 1 supraspiracular, 1 subspiracular (very short); caudal- suranal plate with 3 long setae and numerous shorter ones; suprapedal lobes with setae; 2 on prothoracic, 1 on all other segments.

Ground color very pale greenish white. First, third, fifth, sixth, and seventh abdominal segments with a slight tinge of tan on dorsal and ventral surfaces. Legs and prolegs concolorous with ground color. Spiracles inconspicuous.

Larvae consume shells after hatching.

SECOND INSTAR LARVA: (Measurements and duration are based on 5 specimens.) Beginning of stadium- length, 3.4-3.6 mm.; width, 0.8-1.0 mm.; head diameter, 0.8-0.9 mm. Termination of stadium- length, 5.0-5.9 mm.; width, 1.0-1.2 mm. Duration, 4 days.

Head black with setae as before except apical pair is now replaced by a pair of spiny scoli, 1.4 mm. in length; scoli black basally but fading to a light grey terminally and tipped with black.

Body shape as before. Segments with paired, simple, black setae and paired scoli with black spinules (all scoli the same color as those of the head): prothoracic- cervical shield divided so that there are 3 distinct setae per side, the remainder of the segment with 2 supraspiracular setae, 2 spiracular setae, 1 supraspiracular scoli at juncture of pro- and mesothoracic segments; mesothoracic- 1 dorsal-subdorsal scoli, 2 supraspiracular setae, 1 scoli at juncture of meso- and metathoracic segments; metathoracic- 1 dorsal-subdorsal scoli, 2 supraspiracular setae; first through eighth abdominal- 1 dorsal-subdorsal scoli, 1 supraspiracular scoli, 1 subspiracular scoli; ninth abdominal- 1 dorsal-subdorsal scoli, 1 supraspiracular seta; caudal- 1 dorsal seta; 1 supraspiracular scoli, 3 subdorsal setae, suranal plate with numerous setae; suprapedal lobes with numerous setae.

Ground color light greyish green. Venter whitish green. First, third, fifth, and seventh abdominal segments with a brownish tinge; caudal segment cream. Legs and prolegs concolorous with venter. Spiracles inconspicuous.

THIRD INSTAR LARVA: (Measurements and duration are based on 4 specimens.) Beginning of stadium- length, 5.1-5.9 mm.; width, 1.3-1.5 mm.; head diameter, 1.2 mm. Termination of stadium- length, 7.2-8.1 mm.; width, 1.6-2.0 mm. Duration, 5 days.

Head black with a pair of diagonal light grey streaks at bases of scoli and a small grey dot in the median section of the clypeus. Setae more numerous than before.

Body shape as before. Paired setae and scoli on segments in the same arrangement as before but with the following exception: prothoracic- 2 dorsal setae, 2 subdorsal setae, and 2 supraspiracular setae (all setae arising from black pinacula), 1 supraspiracular scoli at juncture of pro- and mesothoracic segments.

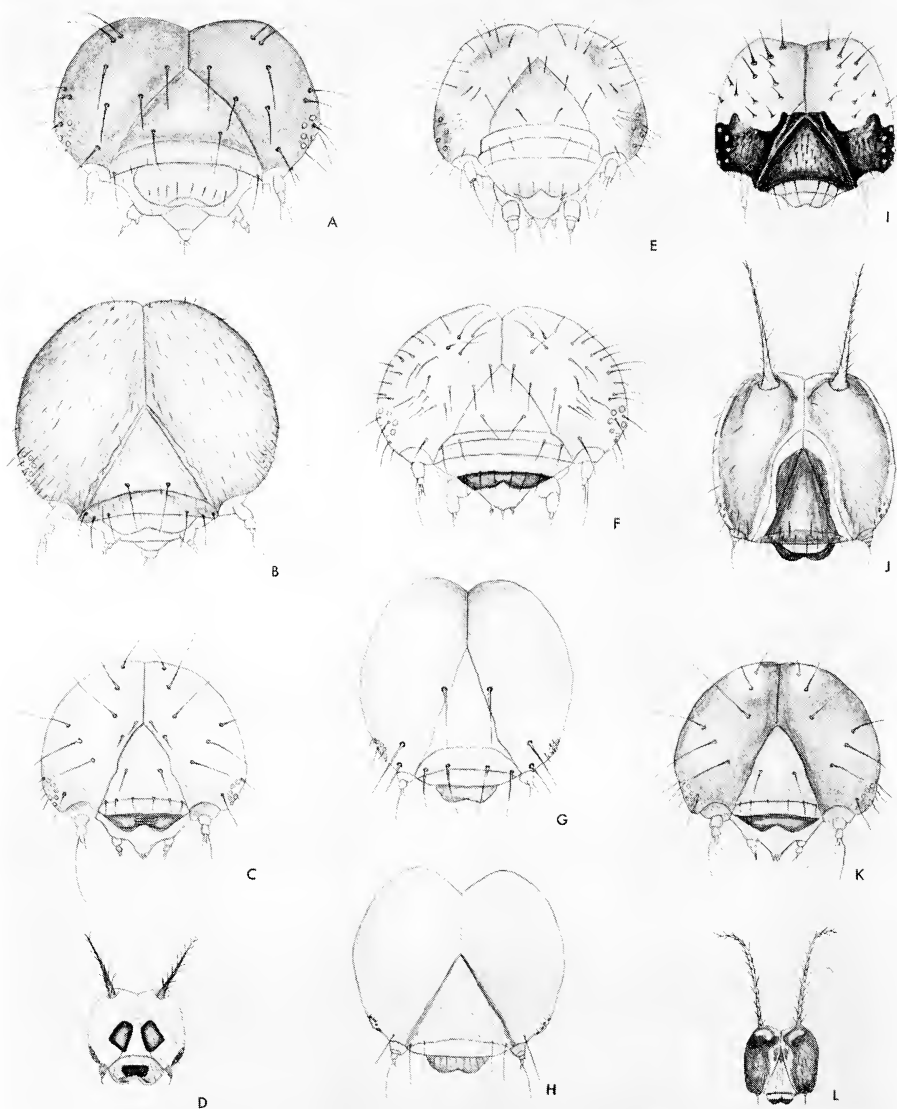


Fig. 5. Larval heads: **A.** *Parides photinus* D., (1st instar) and **B.** 6th instar; **C.** *Heliconius petiveranus* D., 1st instar and **D.** 5th instar; **E.** *Papilio thoas antocles* R. & J., 1st instar and **F.** 3rd instar; **J.** *Dryas julia delila* F., 5th instar; **G.** *Eumaeus minyas* H., 1st instar and **H.** 4th instar; **I.** *Chlosyne janais* D., last instar; **K.** *Eueides cleobaea zorcaon* R., 1st instar, **L.** 5th instar.

Ground color light greyish green but almost obscured by other markings: prothoracic segment with a transverse row of black dots; first through seventh abdominal segments dorsally dark brown with thin, grey streaks and laterally with a narrow, longitudinal, pale yellow band having traces of brown and green; ninth and tenth abdominal segments bright orange. Venter pale green. Legs and prolegs concolorous with venter. Spiracles brown.

FOURTH INSTAR LARVA: (Measurements and duration are based on 4 specimens.) Beginning of stadium- length, 7.5-8.6 mm.; width, 1.9-2.4 mm.; head diameter, 2.3-2.5 mm.

Termination of stadium- length, 16.0-17.3 mm.; width, 3.2-3.9 mm. Duration, 5 days.

Head as before except that the patches of grey at bases of the scole are now more extensive.

Body shape and with setae and scole as before.

Body with same color patterns as before except that now the meso- and metathoracic segments have some brown on their dorsal surfaces. Legs, prolegs, and spiracles as before.

FIFTH INSTAR LARVA: Fig. 3D. (Measurements and duration based on 4 specimens.)

Beginning of stadium- length, 17.4-18.9 mm.; width, 3.2-3.9 mm.; head diameter, 3.0-3.4 mm.

Termination of stadium- length, 27.4-29.1 mm.; width, 4.3-5.4 mm. Duration, 7-8 days.

Head (fig. 5L) as before but grey at bases of scole now more extensive and now on dorsal surface of scole.

Body with setae and scole as before.

Body with same color pattern as before except that the dorsal brown band is now black with numerous thin, grey streaks. Legs, prolegs and spiracles as before.

Larva turns maroon 3 days prior to pupation and on the day immediately preceding pupation, it takes on a completely yellow appearance.

Larva fastens the caudal segment to the stem of the food plant or other substrate and hangs suspended head downward before pupating.

PUPA: Figs. 6D and E. (Measurements and duration are based on 3 specimens.) Length, 19.5-21.0 mm.; maximum width, 7.0-7.8 mm. Duration, 8-9 days.

Head with 1 pair of anterior projections (approximately 4.0 mm. in length) and 1 pair of dorsal projections (slightly shorter in length than the anterior ones). Antennae and proboscis extending to wing margins.

Segments with projections covered very sparsely with fine, simple setae (hair) (projections relatively short unless otherwise mentioned): thoracic- 1 subdorsal; first abdominal- 1 subdorsal, 1 supraspiracular; second and third abdominal- 1 dorsal, 1 subdorsal (approximately 6.5 mm. in length), 1 supraspiracular; fourth through ninth abdominal- 1 dorsal, 1 subdorsal (bifurcated).

Ground color cream with light greyish green mottling. Spiracles inconspicuous.

IMAGO: Fig. 8, E. Adults were very numerous along the borders of the deciduous woods around the village. This was the most common heliconian in the immediate vicinity of the village.

Hoffmann (1940) gives the Mexican range of this subspecies as the warm and hot regions of the Gulf Coast and Chiapas.

Dryas julia delila (Fabricius)

Several authors have made reference to the food plants or to the immature stages of this species: Beebe, Crane and Fleming (1960) - descriptions of egg, all instar larvae, pupa with illustrations of egg, first and fifth instar larvae and pupa, and records the larval food plant as *Passiflora tuberosa* Jacquin; Comstock and Vazquez (1961) - description and illustration of an egg; Fassl (1909), brief mention of egg and larva; Klots (1951)- records *Passiflora* as the larval food plant; Fleming (1960)- description of first instar larva; Muller (1886)- description of larval stages, records *Passiflora ichtyura* as the larval food plant; Seitz (1924)- description of larva and pupa, and records larval food plants as *Passiflora vespertilionis* and *P. ichtyura*; Sepp (1855)- description of larval stages; Wolcott (1923)- records *Passiflora* sp. as the larval food plant; Wolcott, (1936)- records *Passiflora* sp. as the larval food plant.

EGG: (Measurements and duration are based on 3 specimens.) Height, 1.3-1.4 mm.; width, 0.8-0.9 mm. Duration of stage, 4 days.

Cylindrical in shape. Outer surface composed of rectangular reticulations (identical with the egg of *H. petiveranus* and thus, no drawings are included here).

Color orangish yellow (more orange than the egg of *H. petiveranus*).

Eggs are deposited on the undersurfaces of the leaves and/or on the new tendrils of *Passiflora biflora* Lam., the same larval food plant as that of *H. petiveranus*. At the Laguna Cate-maco Locality (see under *H. petiveranus*), females also oviposited on *P. coriacea* Juss.

FIRST INSTAR LARVA: Fig. 3E. (Measurements and duration are based on 3 specimens.) Beginning of stadium- 2.9 mm.; width, 0.2 mm.; head diameter, 0.2 mm. Termination

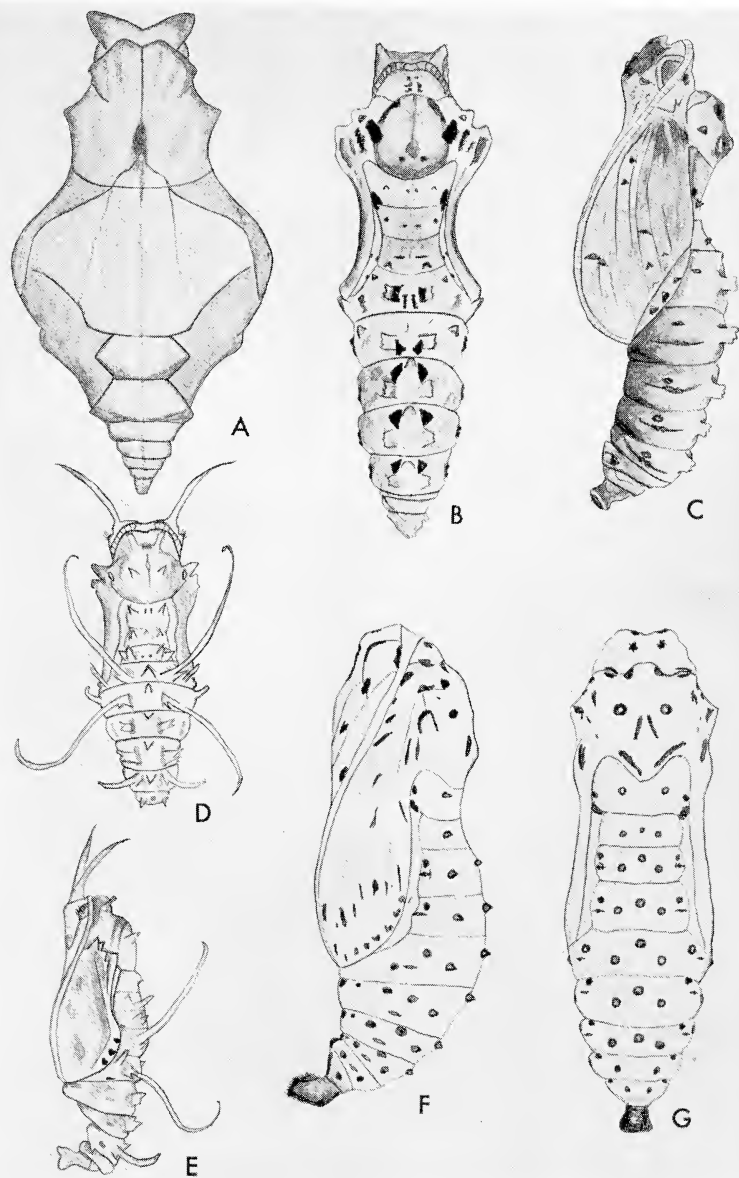


Fig. 6. Pupae: A, *Parides photinus* D.; B, and C, *Dryas julia delila* F.; D, and E, *Eueides cleobaea zorcaon* R.; F, and G, *Chlosyne janais* D.

of stadium- length, 4, 0-4.1 mm.; width, 0, 4-0.5 mm. Duration, 3 days.

Head identical with that of *H. petiveranus* (see fig. 5C); coffee brown in color.

Body cylindrical. Segments with paired, simple, black setae: prothoracic- cervical shield with 3 arranged in a triangular pattern, 2 supraspiracular, 2 spiracular; meso- and metathoracic- 1 dorsal, 1 subdorsal, 2 supraspiracular, 1 spiracular; first through eighth abdominal- 1 dorsal, 1 subdorsal (posterior), 1 supraspiracular, 2 subspiracular; ninth abdominal- 1 dorsal, 1 subdorsal, 1 supraspiracular, 1 subspiracular (very short); caudal- suranal plate with 3 long and numerous short setae; suprapedal lobes with setae: 2 on prothoracic and sixth through ninth abdominal, 1 on all other segments.

Ground color taffy brown. Legs and prolegs concolorous with ground color. Spiracles inconspicuous.

Larvae consume shells after hatching.

SECOND INSTAR LARVA: (Measurements and duration are based on 2 specimens.) Beginning of stadium- length, 4, 8-5.0 mm.; width, 0, 3-0.6 mm.; head diameter, 0, 7-0.8 mm. Termination of stadium- length, 7, 9-8.2 mm.; width, 0, 7-0.9 mm. Duration, 4 days.

Head the same color and with setae as before except that the apical pair is now replaced by a pair of black, spiny scoli, approximately 0.2 mm. in length.

Body shape as before. Segments with paired, simple, black setae and paired black scoli with black spinules: prothoracic-cervical shield divided so that there are 3 distinct setae per side, remainder of segment with 2 supraspiracular setae, 2 spiracular setae, 1 supraspiracular scoli at juncture of pro- and mesothoracic segments; mesothoracic- 1 dorsal- subdorsal scoli, 2 supraspiracular setae, 1 scoli at juncture of meso- and metathoracic segments; metathoracic- 1 dorsal- subdorsal scoli, 2 supraspiracular setae; first through eighth abdominal- 1 dorsal- subdorsal scoli, 1 supraspiracular scoli, 1 subspiracular scoli; ninth abdominal- 1 dorsal- subdorsal scoli, 1 supraspiracular seta; caudal- 1 dorsal seta; 1 supraspiracular scoli, 3 subdorsal setae, suranal plate with numerous setae.

Ground color greenish brown. Bases of scoli on second, fourth, and sixth abdominal segments white. Legs black; prolegs concolorous with ground color. Spiracles inconspicuous.

THIRD INSTAR LARVA: (Measurements and duration are based on 2 specimens.) Beginning of stadium- length, 8, 8-9.1 mm.; width, 1, 0-1.3 mm.; head diameter, 1, 2-1.3 mm. Termination of stadium- length, 10, 7-12.0 mm.; width, 2, 0-2.5 mm. Duration, 5 days.

Head as before but apical scoli slightly longer.

Body shape as before. Paired setae and scoli on segments in the same arrangement as before with the following exceptions: prothoracic- 2 dorsal setae, 2 subdorsal setae (all situated on an undivided cervical shield), 2 supraspiracular setae (situated on individual pinacula), 1 supraspiracular scoli at juncture of pro- and mesothoracic segments.

Ground color dark brown. Bases of scoli on second, fourth and sixth abdominal segments cream. White specks and thin lines on dorsal and lateral surfaces. Legs, and prolegs as before. Spiracles black.

FOURTH INSTAR LARVA: (Measurements and duration are based on 2 specimens.) Beginning of stadium- length, 13, 0-14.1 mm.; width, 2, 1-2.7 mm.; head diameter, 2, 3-2.5 mm. Termination of stadium- length, 17, 0-18.4 mm.; width, 2, 4-3.0 mm. Duration, 4 days.

Head black with apical scoli slightly longer than before. Adfrontals lighter than rest of head.

Body shape and with setae and scoli as before.

Ground color dark brown with a pinkish tinge, particularly at the segmental junctures. White markings on dorsal and lateral surfaces much more extensive and forming thin, discontinuous, transverse bands. A middorsal, discontinuous longitudinal, white band slightly evident. Legs, prolegs, and spiracles as before.

FIFTH INSTAR LARVA: Fig. 3F. (Measurements and duration are based on 2 specimens.) Beginning of stadium- length, 17, 9-18.6 mm.; width, 2, 8-3.5 mm.; head diameter, 3, 3-3.5 mm. Termination of stadium- length, 33, 1-35.0 mm.; width, 5, 0-6.0 mm. Duration, 6-7 days.

Head (Fig. 5J) tricolored- clypeus black, frontals black with cream margins, vertex maroon. Apical scoli now approximately 2.1 mm. in length.

Body shape and with setae and scoli as before.

Ground color pinkish grey. Numerous, thin, transverse, black lines on all segments. Lateral portions of segments with 2 small, irregular cream patches near segmental junctures with a maroon patch between. Venter greyish green. Legs (claws black) and prolegs maroon. Spiracles black.

Two days prior to pupation, the larva fastens the caudal segment to a substrate and hangs suspended head downward.

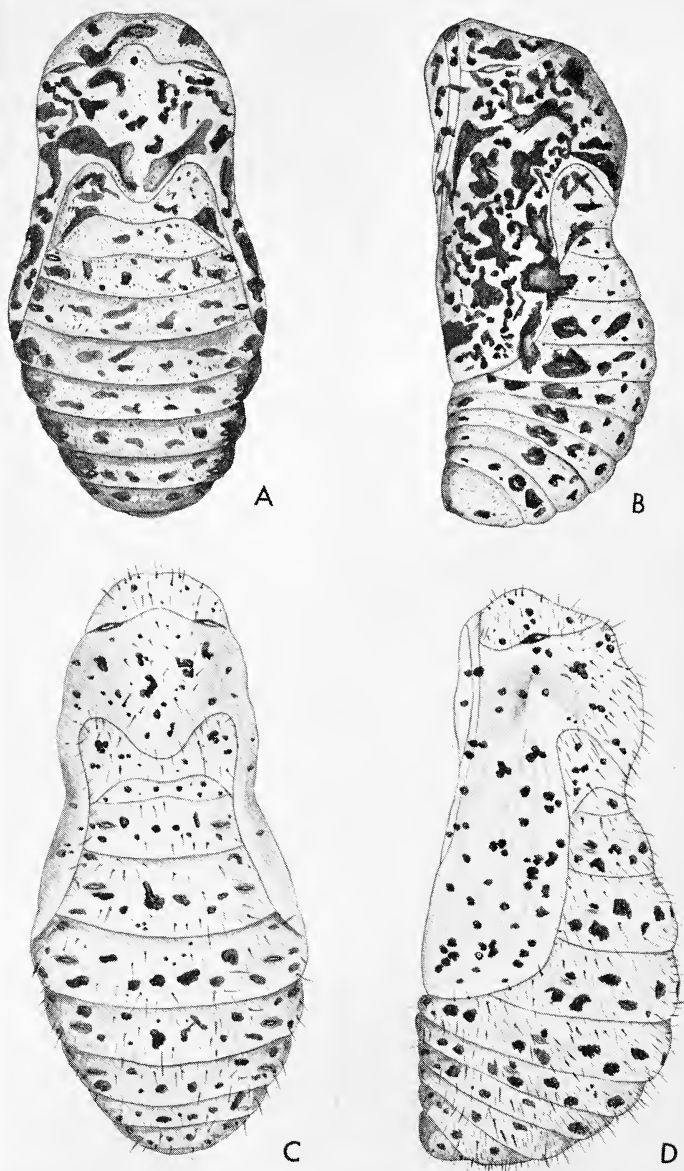


Fig. 7. Pupae: A. and B. *Eumaeus debora* H.; C. and D. *Eumaeus minyas* H.

PUPA: Figs. 6B and C. (Measurements and duration are based on 2 specimens.) Length, 22.0-23.5 mm.; maximum width, 7.0-7.4 mm. duration of stage, 9 days.

Head with 1 pair of slight anterior projections. Antennae extending to wing margins. Proboscis slightly shorter than wing margins.

Prothoracic segment with a middorsal keel and a pair of subdorsal keels. Meso- and metathoracic segments each with a pair of dorsal transparent panes appearing as plates of "mother of pearl". A subdorsal row of small elevated cones on all thoracic segments.

Abdominal segments with a subdorsal keel (these are less pronounced on the first, eighth, and ninth segments).

Ground color brown mottled with various hues of cream, grey, and tan. Wing cases nearly entirely cream.

Pupae made a very audible squeaking sound when it was disturbed.

IMAGO: Fig. 8, F. Adults were abundant in the open, sunny areas in the village and in the surrounding countryside.

Ehrlich (1961) gives the range of this species as southern Florida and southern Texas south throughout the entire Neotropical Region. Hoffmann (1940) states that the subspecies *delila* occurs in all of Mexico.

Euptoieta hegesia hoffmanni W.P. Comstock

There are several references in the literature regarding the life history of this species. However, most of these are just notes as to the larval food plant, *Turnera ulmifolia* L.--yellow primrose (Carpenter and Lewis, 1943; Comstock, 1944; Davenport and Dethier, 1937; Wolcott, 1923; Wolcott, 1936). Swainson (1901) gives a brief description of a larva and pupa; Comstock and Vazquez (1961) describe and picture a second instar larva, a last instar larva and a pupa. Nowhere have I found mention of the egg.

EGG: Fig. 1C. (Measurements and duration are based on 9 specimens.) Height, 0.8-0.9 mm; width, 0.6-0.7 mm. Duration of stage, 4 days.

More or less conical in shape. Outer surface with rectangular reticulations, these less numerous near the micropyle. Micropyle surrounded by an irregular ridge. There is a very close similarity between the egg of *Euptoieta claudia* Cramer as pictured by Comstock (1955) and the egg of this species.

Color milky, light green, the area surrounding the micropyle turning brown on the third day.

Eggs are deposited singly and usually on the undersurfaces of the leaves of *Turnera ulmifolia* L. (Turneraceae). This plant was common in the open areas in the pine woods and in the grassy fields around the village.

Because of several misfortunes, larvae were not sketched.

IMAGO: Fig. 9, A. Adults were abundant in all open areas in and about the village.

Klots (1951) records the subspecies *hoffmanni* as the mainland subspecies getting as far north as Texas. Hoffmann (1940) lists the species as occurring in the entire warm and hot regions of Mexico.

Chlosyne janaeis (Drury)

To my knowledge, there are but three references in the literature to the immatures of this species: Dyar (1911)- brief description of a larva; Edwards (1888)- brief description of a pupa; Schaas (1883)- brief description of a larva and pupa. There is no mention of the larval food plant.

LAST LARVAL INSTAR: Fig. 2C. (Measurements and duration are based on 11 specimens.) Beginning of stadium (approximate measurements)- length, 28.0-30.0 mm.; width, 3.5-4.0 mm.; head diameter, 3.2-3.6 mm. Termination of stadium- length, 44.0-47.3 mm.; width, 5.0-6.3 mm. Duration (approximate), 8 days.

Head (fig. 5I) bicolored- top half orange, lower half black. Numerous fine, simple, black setae arising from small chalazae.

Body cylindrical. Segments with paired, simple, black setae and paired black scole with black spinules: prothoracic- cervical shield with four small scole and several setae, 1 subspiracular scolus; mesothoracic- 1 subdorsal scolus, 1 supraspiracular scolus, 1 subspiracular scolus (small); metathoracic- 1 subdorsal scolus, 1 supraspiracular scolus, 1 subspiracular scolus; eighth abdominal- 2 dorsal scole (1 anterior, 1 posterior), 1 subdorsal scolus, 1 supraspiracular scolus, 1 subspiracular scolus; ninth abdominal- 1 supraspiracular scolus; caudal- 2 dorsal setae (1 ant., 1 post.), 2 subdorsal setae (1 ant., 1 post.), 1 supraspiracular scolus; suprapedal lobes with paired setae: 1 on pro- and mesothoracic segments, first, seventh, eighth, and ninth abdominal segments; two on metathoracic and second through sixth abdominal segments.

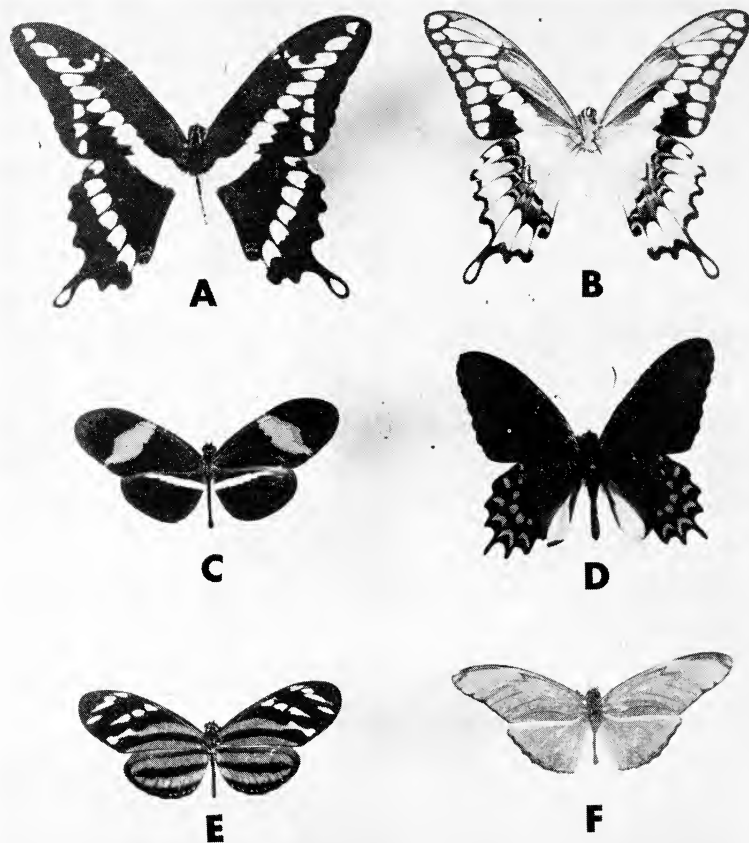


Fig. 8. Adults of: **A.** *Papilio thoas antocles* R. & J. dorsal and **B.** ventral; **C.** *Heliconius petiverannus* R. & J.; **D.** *Parides photinus* D.; **E.** *Eueides cleobaea zorcaon* R.; **F.** *Dryas julia delila* F.

Ground color metallic greyish green. Prothoracic segment light orange. All other segments with: a transverse, glossy black band linking all scoli; a ventral, discontinuous, longitudinal, glossy black band; numerous thin, transverse glossy black lines. Legs and prolegs black. Spiracles black.

Two days prior to pupation, the larva fastens the caudal segment to the substrate and hangs suspended head downward.

Larvae were found feeding on the undersurfaces of the leaves of *Odontonema callistachyum* (S. and C.) Kuntze (Acanthaceae). This plant was common along the shaded stream banks.

PUPA: Figs. 6F and G. (Measurements and duration are based on 7 specimens.) Length, 17.1-19.8 mm.; maximum width, 5.9-6.8 mm. Duration of stage, 8-9 days.

Antennae and proboscis extending to wing margins.

Thoracic segments with 1 pair of subdorsal, small, glossy black pimples.

Abdominal segments with paired, small, glossy black pimples in the following arrangement: first and second abdominal- 1 dorsal, 1 subdorsal, 1 supraspiracular, 1 subspracular; fourth through seventh abdominal- 1 dorsal, 1 subdorsal, 1 supraspiracular (reduced to dots), 1 subspracular (reduced to dots).

Ground color smooth greyish green (slightly lighter than ground color of larvae). Small black lines on head portion. Proboscis covering with black triangular markings (1 per segment), these most conspicuous at terminal portions. Wing cases with several black dashes. Spiracles black.

IMAGO: Fig. 9, B. Adults were common only along streams where the food plant occurred. The closely related species, *C. lacinia* Geyer, was much more numerous than *C. janais*.

Holland (1931) gives the range of this species as "Texas, Mexico, and Central America". Hoffmann (1940) states that the species occurs in the warm and hot regions of Mexico excluding the northeast section.

FAMILY LYCAENIDAE

Eumaeus minyas Hubner

The life history of this species has not been reported previously in the literature.

EGG: Fig. 1D. (Measurements and duration are based on 14 specimens.) Height, 0.5-0.6 mm.; width, 1.2-1.3 mm. Duration of stage, 8-9 days.

Dorso-ventrally flattened, slightly concave on both dorsal and ventral surfaces. Outer surface composed of fine, circular reticulations.

Color light cream, turning pinkish the day prior to larval hatching.

Eggs are deposited usually in clusters of 3-8 on the undersurfaces of the leaves of *Zamia loddigesii* var. *angustifolia* (Regel) Schuster (Cycadaceae). This plant is relatively small (I have never seen an individual greater than one foot in height) and fairly common throughout the pine woods surrounding the village. Each year (March-May) these pine lands are burned by the Indians. This annual burning could easily account for the reduced sizes of the plants. Although the cycads were numerous, it was very hard to acquire *Eumaeus* eggs and larvae. It appears that the female butterflies only oviposit on the tender new fronds that at the time of my visit (June-August) were very difficult to locate.

FIRST INSTAR LARVA: Fig. 4A. (Measurements and duration are based on 19 specimens.) Beginning of stadium- length, 2.0-2.1 mm.; width, 0.2-0.3 mm.; head diameter, 0.3 mm. Termination of stadium- length, 4.0-4.2 mm.; width, 1.1-1.2 mm. Duration, 2 days.

Head (Fig. 5E) brownish orange. Several minute, tan setae on clypeus and labrum and on frontals. Ocelli brown.

Body dorso-ventrally compressed. Segments with paired, simple black setae: prothoracic-cervical shield with 2 dorsal, 4 subdorsal, remainder of segment with 5 supraspiracular, 1 spiracular, 2 subspiracular; mesothoracic- 2 dorsal, 2 subdorsal, 2 supraspiracular; metathoracic- 5 dorsal- subdorsal, 2 supraspiracular, 4 spiracular- subspiracular; all abdominal- 6 subdorsal-subdorsal, 2 supraspiracular, 4 subspiracular; all segments (except the prothoracic) with a small, elevated inconspicuous, transverse ridge appearing gelatinous and clear.

Ground color brownish orange (concolorous with head color) turning reddish on second day. Areas beneath the previously described ridges on the metathoracic through the sixth abdominal segments become white on the second day, the white not confined to the entire ridge area but so situated as to give the impression of a series of "figure 8's", one per segment. Legs and prolegs concolorous with ground color. Spiracles inconspicuous.

Larvae do not consume shells.

SECOND INSTAR LARVA: (Measurements and duration are based on 18 specimens.) Beginning of stadium- length, 4.2-4.3 mm.; width, 1.3-1.4 mm.; head diameter, 0.9-1.0 mm. Termination of stadium- length, 7.5-8.1 mm.; width, 2.3-2.6 mm. Duration, 2 days.

Head as before.

Body dorso-ventrally compressed with lateral expansions now very evident. Prothoracic segment with cervical shield and setae as before. All other segments with numerous fine, simple, black setae, these not confined to any particular arrangement except that they are less numerous near the segmental junctures. There is a predominance of slightly longer setae on the terminal portions of the ridges. These terminal areas now appear as small verrucae.

Ground color brilliant, glossy, strawberry red. Ridges still clear and gelatinous looking, however, the "figure 8" markings beneath the metathoracic through the sixth abdominal segments are now cream. Legs, prolegs, and spiracles as before.

THIRD INSTAR LARVA: (Measurements and duration are based on 13 specimens.) Beginning of stadium- length, 10.9-11.6 mm.; width, 2.6-2.8 mm.; head diameter, 1.6-1.9 mm. Termination of stadium- length, 15.0-16.2 mm.; width, 4.7-5.0 mm. Duration, 3-4 days.

There is no apparent change from the last instar with the exception that the markings beneath the ridges are now medium yellow.

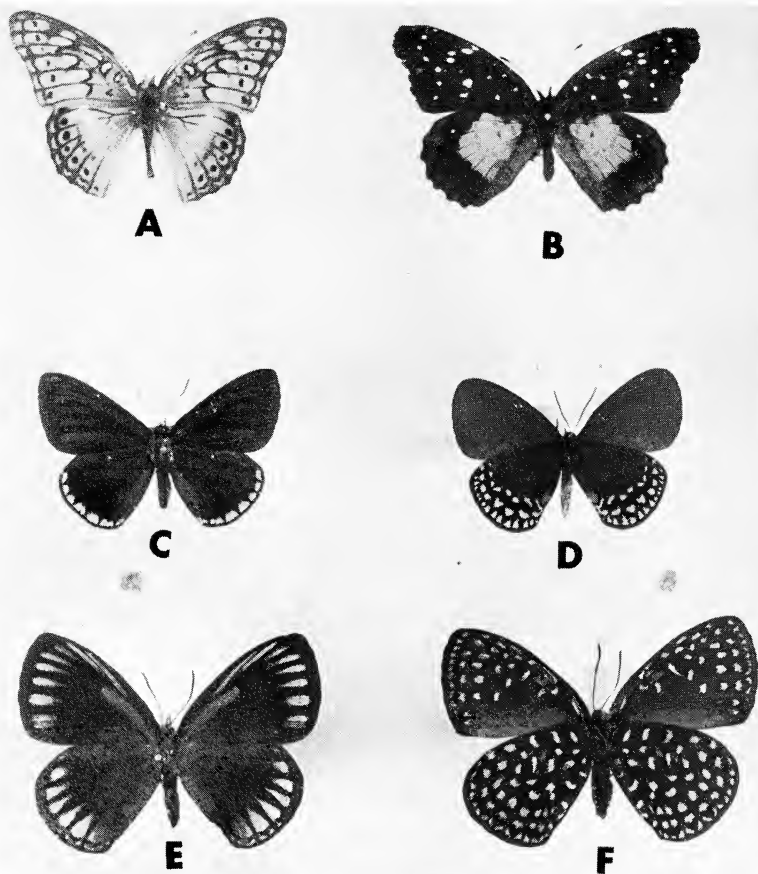


Fig. 9. Adults of: A. *Euptoieta hegesia hoffmanni* W.P.C.; B. *Chlosyne janais* D.; C. and D. *Eumaeus minyas* H.; E. and F. *Eumaeus debora* H.

By the time this stage is reached, the larvae in nature are often in a precarious situation. The new fronds of the plants have been consumed, leaving the older, thick, leathery ones. The latter are apparently unsuitable as food for the larvae probably resulting from an inability of the larval jaws to cut these older, leathery tissues. They do not feed on these older tissues but instead abandon the plants and crawl along the ground in search of other plants that might have new, fresh foliage. This phenomenon has been reported by Schwarz (1888) for larvae of *Eumaeus atala* Poey, a species that occurs in the pine lands of southern Florida. To be sure, a majority of the *E. minyas* caterpillars probably perish at this time for although *Zamia* grows in clumps (individual plants are usually 5-10 feet apart), there might not be a plant with new foliage for distances as great as 60-100 feet. The probability of a caterpillar which is wandering about at random finding such a plant seems far from good. In addition, a great many larvae probably perish during the annual spring burnings which were mentioned above.

I saw caterpillars crawling along the ground on only two occasions. However, I often observed plants with recently defoliated new fronds and noticed that no larvae were present on the older, uneaten foliage. The Popolucas who say that they frequently see the brilliantly colored "gusanos" crawling on the ground, associate this behavior with this particular species.

FOURTH INSTAR LARVA: Figs. 4 B and C. (Measurements and duration are based on 11 specimens.) Beginning of stadium- length, 16.6-17.7 mm.; width, 6.0-6.9 mm.; head diameter, 3.1-3.3 mm. Termination of stadium-length, 25.2-27.0 mm.; width, 8.1-9.5 mm. Duration, 8-9 days.

Head (Fig. 5H) with more setae than before.

Body with no apparent change from the previous stage.

It is interesting to note here that larvae in captivity accepted the fresh fronds of *Ceratozamia mexicana* (the food plant of the larvae of *Eumaeus debora*, which is discussed below) without any hesitancy.

The larva discontinues eating 3 days prior to pupation. Two days prior, it fastens the caudal segment to the substrate and spins a thoracic girdle consisting of several silken threads. This caudal attachment is very insecure and practically all of my specimens wound up dangling in mid air, the thoracic threads being the only means of support. This "breaking loose" probably occurs in the field as well; the only chrysalid taken in the field was brought to me after being found lying unattached on the ground.

PUPA: Figs. 7C and D. (Measurements and duration are based on 10 specimens.) Length, 15.1-16.0 mm.; maximum width, 7.0-7.9 mm. Duration of stage, 14 days.

Antennae extending to wing margins. Proboscis slightly shorter than wing cases.

Ground color a uniform glossy brownish orange. The yellow bands of the last instar (beneath the ridges) very conspicuous for the first 24 hours following the last molt but disappear entirely after that time period. Numerous black dots and blotches on all surfaces forming dorsal, sub-dorsal, supraspiracular, spiracular, and subspracular rows. Dense, fine, simple, tan, setae on all surfaces except the wing cases. Spiracles black and conspicuous.

Dr. J. Downey (personal communication) informs me that the pupa has a stridulatory organ between the fifth and sixth abdominal tergites. This sound producing organ which is apparently widespread in the Lycaenidae will be described by him in his forthcoming paper on that subject. I did not notice any sound being produced by my pupae in the field.

IMAGO: Fig. 9 CD. Adults were extremely numerous in the pine lands. This species must have an extremely high reproductive potential for despite the apparently high larval mortality rate as a result of the annual forest burnings, an inadequate supply of acceptable food, and presumably heavy predation (occurring when the larvae are crawling along the ground), the species is by no means on the verge of extinction in the Ocotil area. Undoubtedly the relatively short duration of the larval stage requiring but 15 days is a distinct advantage to this species and an adaptation to the particular environment.

Adults were not confined to the pine lands exclusively but were found in the deciduous, tropical forests in the ravines. No cycads grew in these habitats so that the distribution of the adults is not restricted by the distribution of the larval host plant.

Holland (1931) states that this species is "common from southern Texas to northern Argentina". Hoffmann (1940) states that the species occurs in Mexico in the warm and hot coastal regions and in Yucatan.

Eumaeus debora Hubner

Two authors have made mention of the immatures of this insect: Murillo (1902)- describes a larva, pupa and records the larval food plants (plants under cultivation) as *Dioon edule*, *Cycas revoluta*, and *Macrozamia* sp.; Comstock (1948)- illustrates a larva and pupa of this species and lists the food plant as the cycad *Dioon edule* Lindl. His descriptions were based on specimens that were taken in northeastern Mexico. These descriptions do not correlate exactly with mine, a matter which might be attributed to geographic variation.

EGG: Fig. 1E. (Measurements based on 9 specimens.) Height, 0.4-0.5 mm.; width, 0.9-1.0 mm. Duration of stage unknown because of nonviable material.

Dorso-ventrally flattened, slightly concave on both dorsal and ventral surfaces. Outer surface composed of fine, reticulations in the form of small six-rayed stars.

Color a dull white.

Eggs are deposited in clusters (may go over 50) usually on the undersurfaces of the leaves of *Ceratozamia mexicana* Brongn. (Cycadaceae) but sometimes on the reproductive cones. It appears that females (similar to the females of *E. minyas*) "prefer" to oviposit on the very new, fresh fronds. These plants (which may attain a height of 3-4 feet) grew in small, localized clusters in the virgin rain forest on the upper slopes of the volcano. I failed to find plants below 3000 feet in elevation.

THIRD INSTAR LARVA (presumably): (Measurements and duration are based on 5 specimens.) Beginning of stadium- length, 9.1-9.8 mm.; width, 2.6-3.0 mm.; head diameter, 1.9-2.0 mm. Termination of stadium- length, 18.0-18.9 mm.; width, 4.4-5.1 mm. Duration, 6 days.

Head brownish orange with a few very fine setae, particularly on the clypeus and labrum. Ocelli brown.

Body slightly dorso-laterally flattened and with lateral expansions. Prothoracic segment with triangular cervical shield; shield with numerous small, simple, black setae. All segments each with a small, elevated, transverse ridge in posterior portion of segment appearing gelatinous and clear. These ridges rise at terminal portions into small verrucae bearing numerous, black setae in no apparent arrangement except that they are less numerous on the segmental junctures.

Ground color a glossy carmine (Comstock, 1948, reports the color as scarlet), the red far less vivid and the gloss far less pronounced than with *E. minyas*. White markings (Comstock, 1948, reports orange-yellow markings) beneath meso thoracic segment through the seventh abdominal segment with the following shapes: mesothoracic- two diagonal patches; metathoracic- an elongated lopsided "figure 8"; seven abdominal- rounded bars.

Larvae are apparently gregarious: the 5 specimens listed above were found together on the undersurface of a single cycad leaflet.

FOURTH INSTAR LARVA (presumably): Fig. 2F. (Measurements and duration are based on 5 specimens.) Beginning of stadium- length, 19.0-20.1 mm.; width, 6.1-6.0 mm.; head diameter, 3.0-3.3 mm. Duration, 8-9 days.

Head appears to be indistinguishable from that of *E. minyas* (consult fig. 5H).

Body shape and with markings as before. Claws of legs black. Prolegs as before. Spiracles dark brown.

The larva discontinues feeding 3 days prior to pupation. On the second day before pupation, the lateral portions of the meso- and metathoracic segments take on a brownish tinge and the segmental junctures between these same two segments take on a sky blue color (beneath the ridge).

The larva attaches to the undersurface of the cycad leaf by fastening the caudal segment and by spinning a girdle of several silken threads around the thoracic portion. As with *E. minyas*, the caudal attachment is not very secure.

PUPA: Figs. 7A and B. (Measurements and duration are based on 4 specimens.) Length, 19.5-20.9 mm.; maximum width, 9.5-9.9 mm. Duration of stage, 13-14 days.

Antennae extending to wing margins. Proboscis slightly shorter than wing cases.

Ground color uniform glossy brownish orange, slightly darker than the pupa of *E. minyas*. The nine white bands of the last instar (beneath the ridges) are very conspicuous for the first 24 hours following pupation but disappear entirely after that time period (Comstock, 1948, pictures a pupa with the bands still evident). Numerous irregular black blotches and dots on all surfaces (much more numerous than on *E. minyas*) forming multiple dorsal, subdorsal, supraspiracular, and subspiracular rows. Numerous, very fine, tan setae (hairs) on thoracic and abdominal segments (Comstock, 1948, reported hairs only on the thoracic segments), these non-evident except under microscopic magnification.

Pupae are found in groups. I have found as many as 37 pupal cases in close association.

Dr. J. Downey (personal communication) informs me that the pupa has the stidulatory organ between the fifth and sixth abdominal tergites and that the organ is much more evident in this species than it is in *E. minyas*.

IMAGO: Fig. 9, E. Adults were common only in or in the immediate vicinity of the virgin forests on the upper slopes of the volcano and only in relatively close proximity to the cycad hosts. They did not fly in the shaded depths of the forest but occurred in small, sunny openings existing as a result of fallen trees or landslides. On several occasions, I saw individuals flying 15-20 feet above the crater rim at an elevation of 5100 feet.

Hoffmann (1940) gives the range in Mexico of this species as the eastern mountain system as far north as southern Tamaulipas as well as Oaxaca, Puebla, the Central Plateau region, the Valley of Mexico, the mountains of Guerrero and Morelos. My specimens from the Sierra Tuxla represent the most southeastern record of this species in Mexico.

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THE GENERIC, SPECIFIC AND LOWER CATEGORY NAMES OF THE NEARCTIC BUTTERFLIES

PART 3 — Argynnis
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THE PRESENTATION OF THE NAMES used for the Argynnis will follow the format of the two earlier parts of this work but with some modifications.

Since the data for the generic names associated with these butterflies have already been published (McHenry, 1963) in a list of the world-wide generic names for the group, no further discussion of the genera will be presented.

The Nearctic Argynnis can be rather easily separated into two generic groups based on relative size without doing harm to more sophisticated considerations or disturbing the arrangements that have historically been followed for this group. The smaller species will be considered under the generic name *Boloria* Moore; the larger species will be considered under the generic name *Argynnis* Fabricius.

A common list of 270 specific names for all the Argynnis in an alphabetical arrangement will precede the main body of text; each name in the list will have an indication as to the genus and as to the species number under which it may be found in the main body of text. Misspellings are not given in the list but are included under the appropriate names in the main body of text.

In the text dealing with the *Boloria*, the names of the 14 species of *Boloria* recognized by dos Passos (1964) have been used as a convenience in presenting 95 names for this group although three additional species names, *pales* [Denis & Schiffermüller], *dia* Linnaeus and *euphrosyne* Linnaeus, have been added in order to present references to names which have been historically associated with some Nearctic species.

In the text dealing with the *Argynnis*, the names of the 13 species of *Speyeria* Scudder recognized by dos Passos (1964) have been used as a convenience in presenting the 175 names for this group.

In the body of the text, the *Boloria* and *Argynnis* will be considered separately. The recognized species names for each group will be presented in alphabetical order and in turn the names associated with them by dos Passos (1964) will be given alphabetically under them.

Since the purpose of this paper is to present data for consideration rather than to present conclusions, all generic and specific names are used or arranged here only as a convenience in presenting them and without any implied approval of their use. As a great deal of subjective judgment is required in attempting to determine generic or specific relationships in such a confusing group as this, there will always be differences of opinions among students.

LIST OF SPECIES AND LOWER CATEGORY NAMES USED
OR AVAILABLE FOR THE ARGYNNIDS

(A = *Argynnis*; B = *Boloria*)

adiante A-8	beani A-2	coronis A-4
adiaste A-8	behrensii A-13	cottlei A-2
alaskensis B-10	bellona B-3	creelmani A-3
alaskensis B-13	benjamini A-11	cunninghami A-11
albequina B-16	bernardensis A-4	cybele A-5
alberta B-1	bischoffi A-11	cynna A-13
albrighti A-8	boisduvalii B-17	cypris A-1
alcestis A-1	boharti A-8	daphnis A-5
apacheana A-12	bremnerii A-13	daphnis A-5
alticola B-7	browni B-9	dawsoni B-7
americana B-15	brucei A-11	denali B-7
ammiralis B-3	butleri B-4	dennisi A-2
andersoni B-8	byblis A-1	dia B-5
aphirape B-7	caelestis B-7	diana A-6
aphrodite A-1	calgariana A-3	distincta B-2
arctica B-4	californica A-4	dodgei A-2
arge A-11	caliginosa A-9	dolli A-10
argenticollis B-8	callippe A-3	dorothea A-2
arizonensis A-2	canadensis A-2	edonis A-7
artonis A-11	carolae A-13	edwardsii A-7
ashtaroth A-10	carpenterii A-5	egleis A-8
astarte B-2	chariclea B-4	egleis A-8
astarte A-8	charlottii A-5	elaine A-3
astarte A-10	chemo A-2	eldorado B-6
astarte A-11	chitone A-2	electa A-2
atlantis A-2	clemencei A-8	epithore B-6
atossa A-8	clio A-11	epithore B-6
atrocostalis B-16	coerulescens A-12	erinna A-11
baal A-5	columbia A-1	eris A-11
bakeri A-1	columbia A-1	ethne A-1
banffensis B-1	comstocki A-3	eunomia B-7
baroni A-3	conchyliatus A-13	euphrosyne B-8
bartschi A-1	conquista A-9	eurynome A-11
baxteri B-16	cornelia A-2	fasciata B-3

- fieldi A-11
 freija B-9
 freya B-9
 frigga B-10
 gallatini A-3
 garretti A-13
 gerhardi A-3
 gibsoni B-10
 gloriosa A-13
 grandis B-17
 gregsoni A-9
 greyi A-2
 gronlandica B-15
 gunderana B-16
 gunderi B-9
 gunderi A-4
 gunderi A-11
 halli B-13
 halycone A-4
 harmonia A-3
 harperi B-7
 heleni B-17
 heleni A-2
 hennei A-4
 hermosa A-12
 hesperis A-2
 hippolyta A-13
 hollandi A-2
 hutchinsi A-2
 hughi A-1
 hydaspe A-9
 idalia A-10
 igeli A-11
 improba B-11
 infumata A-10
 ingens B-17
 inornata A-3
 irene A-2
 jenistai B-3
 jenningsae B-16
 jesmondensis A-11
 juba A-3
 kleenei B-3
 krautwurmi A-5
 kriemhild B-12
 labradorensis B-17
 laddi B-7
 lais B-7
 lais A-2
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LIST OF SPECIES AND LOWER CATEGORY NAMES
USED OR AVAILABLE FOR BOLORIA

1. BOLORIA ALBERTA (W. H. EDWARDS).
alberta, Argynnis W. H. Edwards. 4 June 1890. Canadian Ent. 22(6): 113-114. "From one ♂ and two ♀ sent me by Mr. Thomas E. Bean, and taken at Laggan, Alberta. He writes: "This Argynnis, I think, occurs strictly above timber line, and not very near it either, though also not at the highest points in the mountains." No date data given.
banffensis, Brenthis alberta Gunder. 28 Mar. 1932. Pan-Pacific Ent. 8(3): 125. "Holotype ♂; ... Banff, Alberta, Canada, July 21, 1930. Type in author's collection."
2. BOLORIA ASTARTE (DOUBLEDAY).
astarte, Melitaea Doubleday. [4 Oct. 1847]¹. In Doubleday and Hewitson, Genera Diur. Lepid. 1 (12): plate 23, fig. 5 (named on plate). Text published later: 1 (21) on page 181 where in a note he gives the name as Argynnis astarte. No sex, date, series nor locality data given.
distincta, Brenthis Gibson. 10 Jan. 1920. Rept. Canadian Arct. Exped. 3(i): 25i, 54i; pl. 4, fig. 12. "Type, a female, from Harrington creek, Yukon Territory, lat. 65° 05' July 30, 1912... Two paratypes, one male and one female, the former from Eduni mountains, 6,000 feet, Gravel River, Northwest Territories, July 8, 1908, ... and the latter from Tindir creek, Yukon Territory, lat. 65° 20' international boundary, July 25, 1912..."
victoria, Argynnis W. H. Edwards. 21 Sept. 1891. Canadian Ent. 23 (9): 198-199. "Described from a single male taken with others of both sexes by Mr. Thos. E. Bean, at Laggan, Alberta [Canada]". "The female I have not seen, but Mr. Bean tells me that it is essentially like the male". Edwards quotes Bean: "It is strictly alpine... The last week in July seems to be the time of flight."
3. BOLORIA BELLONA (FABRICIUS).
ammiralis, Argynnis Hemming. Dec. 1933 [before 19th]². The Entomologist 66(847): 276, no. 7. A new name for P[apilio]. N. P. bellona Fabricius, 1775 [17 Apr.]³ which he considered as a homonym of Pap. Helicon, bellona Cramer, [1776]³. Uitland. Kapellen Voorkom. Drei Waereld-Deelen Asia, Africa en America 1(2): 20, fig. E-F; pl. 13, figs. E-F; 1(8): 152.
bellona, P[apilio]. N[ymphalis]. P[haleratus]. Fabricius. 1775 [17 Apr.]³. Systema Entomologicae; pp. 517-518, no. 317. "Habitat in America". No sex, series nor date data given. In applying Opinion 516 issued 16 May 1958 by the International Commission, the name Papilio bellona Fabricius would have precedence over the name Papilio bellona Cramer which is a different butterfly.
fasciata, Argynnis bellona Cockerell. Apr. 1889. The Entomologist 22(311): 99. Cites a brief description of an unnamed specimen in Maynard (Butt. N. England; pp. 27-28 (in part), under no. 31; [Feb. 1886]⁴). Maynard's specimen was taken "in Massachusetts". No sex nor date data was given by Maynard.
jenistae, Boloria toddi Stallings and Turner. 15 Jan. 1947. Canadian Ent. 78(7-8): 135-136. "Holotype: Male... Lloydminster, Sask-

[atchewan], [Canada] 5/27/41... Allotype: Female... Lloydminster, Sask. 5/8/41... Paratypes: 68 males and 5 females collected at Lloydminster and Haidan, Sask., during May, June and July, 1941 to 1945... Holotype and allotype will be placed in the National Museum at Washington, D. C. "

kleeni, Brenthis bellona Watson. Sept. - Dec. 1921. Jour. New York Ent. Soc. 28(3-4): 171-172. "This beautiful aberration was captured... at West Hartford, Connecticut, May 3, 1921. Holotype female, in the collection of The American Museum of Natural History..."

myrina, Papilio Nymph[alis]. Phalerat[us]. Martyn, 1797. Psyche, Figs. Nondescr. Lepid. Ins. (?): 5, 5; plate [1]: figs. [2]-[3]. ♂ ? described. "Our original from New Georgia". No series nor date data given. Misidentifies Pap. Nymph. Phaler. myrina Cramer [1777]³.

pardopsis, B[renthis]. bellona Holland. 10 Oct. 1928. Ann. Carnegie Mus. 19(1) art. 3: 45, no. 11b. 1 ♀ described. "... taken at Crafton, Allegheny County, P[ennsylvania]..." No date given.
toddi, B[renthis]. bellona Holland. 10 Oct. 1928. Ann. Carnegie Mus. 19(1) art. 3: 44-45, no. 11a. "Type ♂, St. Margarets River, July 5, 1917, C[arnegie]. M[useum]. Acc. No. 5858, Todd Coll.; allotype ♀, East Main, July 8, 1914, C. M. Acc. No. 5269, Todd. coll.; four male paratypes from St. Margarets and Moisie Rivers, Quebec". In the first part of the description he says: "From the interior of Labrador we have received a good series of specimens..."

4. BOLORIA CHARICLEA (SCHNEIDER).

arctica, A[rgynnis]. Zetterstedt. [1839, after 31 Mar.]⁵. Insecta Lapponica (5): col. 899, no. 18. ♀ described. "Hab. in Groenlandia, e qua mihi per D. Westermann benevole missam possideo. (Groenlandia.)". No date nor series data given.

butleri, Argynnis W. H. Edwards. 18 Mar. 1883. Canadian Ent. 15 (2): 32-33. "From 1 ♂ taken at Cape Thompson, North-west America, July 19, 1881, and 1 ♀ taken at Kotzebue Sound, July 14th, 1881..." Spelled butlerii by Edwards; Trans. Amer. Ent. Soc., 11: 273, no. 146, 1884.

chariclea, Papilio Schneider. 1794. Neu. Mag. fur die Liebhaber der Entomologie 1(5): 588-589. [Lapland] (from article title). No sex, series nor date data given. Spelled churcilea by Johansen. 7 Nov. 1921, Rept. Canadian Arct. Exped. 1913-18 3(k): 36k. Spelled carichlea by Zetterstedt; [1839, after 31 Mar.]⁵; Insecta Lapponica (5): 899, under no. 18. Spelled churchilea by dos Passos; 1964, The Lepid. Soc. Memo ir 1: 90, under no. 608a.

obscurata, A[rgynnis]. chariclea M'Lachlan. 23 May 1878. Jour. Linnean Soc. (Zoology) 14(74): 109-111. "There is one ♀ of this form 81° 42' N." No date data given.

oenone, Arg[ynnis]. Scudder. Mar. 1875. Proc. Boston Soc. Nat. Hist. 17(3) sig. 19: 297-299. "22 specimens, 12 ♂, 6 ♀, 4 doubtful, Labrador (A. S. Packard, Jr.), Fort Simpson, Great Slave Lake, British America (W. H. Edwards), Natashquan, Southern Labrador (W. Cooper), Colorado (T. L. Mead)." No dates given. Inadvertently proposes a name for what he described

as Brenthis chariclea (Schneid.) Herr.-Schaeff. "This is the butterfly... also distributed by me in former years under the Ms. name of Arg. Oenone."

5. BOLORIA DIA (LINNAEUS).

dia, P[apilio], Nymphalis. [Phaleratus] Linnaeus, 1758. Syst. Nat., 10th Ed. 1: 785, no. 207. "Habitat in Austria." No sex, series nor date data given.

nenouis, Brenthis Reakirt, [11 June 1866]-[13 Feb. 1867]⁶. Proc. Acad. Nat. Sci. Phila. [18] (3): 247, no. 22. ♂ described, "Hab. - California. (Coll. Tryon Reakirt,)" No series nor date data given. Strecker, who later possessed Reakirt's collection said (Lepid., Rhopal. and Heter., Indig. and Exot. Suppl. 3: 22; 1900): "1 ♂" which he considered to be dia Linnaeus.

6. BOLORIA EPITHORE (W.H. EDWARDS).

eldorado, Brenthis epithore Strand, June 1915. Archiv für Naturgeschichte, A 80(11): 156. "6 Ex. von Plumas Co[unty]. [California] 10. - 17. VI., ein von Eldorado Co[unty]. [California] 25. - 28. VI. 13."

epithore, Argynnis W.H. Edwards (Boisduval Ms. name). [9 May 1864]⁷. Proc. Ent. Soc. Philadelphia 2(4): 503-504. "From a male sent me from California..." No date given.

epithore, Argynnis Boisduval. [1869, before 1 Nov.]⁸. Ann. Soc. Ent. Belgique 12: 58, no. 50. ♂ and ♀ described. "M. Lorquin a trouvé cette espèce dans les hautes montagnes de l'est où elle est fort rare et difficile à prendre". No dates given. A homonym of Argynnis epithore W.H. Edwards, [9 May 1864].

obscuripennis, Brenthis epithore Gunder, 7 Jan. 1926. Entomological News 27(1): 7, no. 9; plate I, fig. 9. "Data: Holotype ♀... (Author's Coll.), Chilcolin, British Columbia, Canada, May 30, 1915."

wawonae, Brenthis epithore Gunder, 18 May 1924. Entomological News 35(5): 156; plate 2, fig. F. "Data: Holotype ♂. (Author's Coll.), Wawona, Mariposa County, California; July 6, 1922."

7. BOLORIA EUNOMIA (ESPER).

aphirape, [Papilio] Hübner. [24 Dec. 1799]-[13 Apr. 1800]⁹. Samm. Europäischer Schmett. (Papiliones): plate 5, figs. 23-25; page 8 only, no. 1 (published later). ♂ and ♀ described. No date, series data nor locality given. Hübner considered Pap. eunomia Esper as a synonym.

alticola, [Brenthis] aphirape Barnes and McDunnough, 15 Apr. 1913. Contrib. Nat. Hist. Lepid. N. Amer. 2(3): 97-98. "... and have made types and cotypes of 5 ♂'s and 2 ♀'s from Hall Valley, Colo [rado]., (June 21-30) (Barnes) contained in Coll. Barnes." A homonym of Argynnis angarensis alticola Sushkin and Tsetverikov, 20 Apr. (3 May) 1907, Horae Soc. Ent. Rossicae 38(1-2): 18.

caelestis, Argynnis apherape Hemming. Dec. 1933 [before 19th]². The Entomologist 66(847): 275, no. 5. A new name for Brenthis apherape alticola Barnes and McDunnough, 15 Apr. 1913, which is a homonym of Argynnis angarensis alticola Sushkin and Tsetverikov, 20 Apr. (3 May) 1907.

dawsoni, Brenthis apherape Barnes and McDunnough, 12 July 1916. Canadian Ent. 48(7): 222-223. "Types - A long series of ♂'s and ♀'s from Hymers, Ont[ario]. [Canada] (June 15-30) in Coll. Barnes."

- denali, Brenthis (Clossiana) aphirape Klots, 17 Dec. 1940. Jour. New York Ent. Soc. 48(4): 413-414. "Types: Holotype ♂, July 25, 1931, and allotype ♀, July, 1931, McKinley National Park"[Alaska]. Several paratypes with July dates taken in various years are reported from the same locality as the primary types as well as from Cantwell (S. of Fairbanks) and from Alfred Creek Camp also in Alaska. "The holotype, the allotype and most of the paratypes are in the American Museum of Natural History. Paratypes are in the collections of Cyril dos Passos and the author."
- eunomia, Papilio. Nymphalis. Phaleratus. Esper. [1799]¹⁰. Die Schmetterlinge. Suppl. Theils 1 (?): 94, no. 212; pl. 110, no. 5. ♂ described. No series nor locality data given. I have fixed the date on the appearance of the text; the date of the plate's appearance is unknown; the name on the plate is N. Phaler. Eunomia.
- harperi, Brenthis aphirape dawsoni Gunder, 30 June 1934. Canadian Ent. 66(6): 127. "Holotype - ♂, ... Churchill, Man[itoba]., Canada, July 11, 1933. Type to be deposited in the Calif. Academy of Sciences..."
- laddi, Clossiana aphirape Klots, 22 Mar. 1940. American Mus. Nov. No. 1054: 4. "Type Series. - All specimens of type series from Snowy Range, Albany Co.[nty]., Wyo[ming]. Holotype ♂, 9 ♂ and 3 ♀ paratypes, July 7, 1939, collected by Ladd and Klots in willow bog, Hudsonian Zone, alts. 10,400 to 10,800 ft. Allotype ♀, 1 ♂ and 1 ♀ paratype, August 13, 1935, collected by Klots, in willow bog, near Class (Lewis) Lake, Hudsonian Zone, alt. 10,900 ft. 1 ♂ paratype (with wings incompletely expanded) July 17-23, 1935, collected by Klots, in willow bog near Class (Lewis) Lake, Hudsonian Zone, alt. 10,900 ft. Holotype, allotype, 3 ♂ and 1 ♀ paratype in The American Museum of Natural History. The remainder of the paratypes are in the author's collection. Some will be distributed to museums."
- lais, Argynnis. Scudder, Mar. 1875. Proc. Boston Soc. Nat. Hist. 17(3) sign. 19: 294-296. "2 ♂, 2♀, Caribou Island, Straits of Belle Isle, Labrador, (A.S. Packard, Jr., S.P. Butler). Specimens have also been taken at Mackenzie River (W.H. Edwards) and in Colorado (T.L. Mead)." No date data given. Inadvertently proposes a name for what he describes as Brenthis aphirape Hübner.
- nichollae, Brenthis aphirape Barnes and Benjamin, 8 Dec. 1926. Bull. Sou. Calif. Acad. Sci. 25(3): 92, no. 188d. "Type locality: Rocky Mts. Number and sexes of types: Holotype ♂, Allotype ♀, 2 ♂ 1 ♀ Paratypes; Mrs. B. Nicholl, ex Coll. Oberthür." No date data given.
- ossianus, Argynnis Boisduval, 1832. Icon. Hist. Lepid. Nouv. Peu Connu 1(?): 94-95, no. 1; plate 19, figs. 1-3. ♂ and ♀ described. "Elle se trouve dans le nord de la Laponie, au Cap-Nord et au Labrador." No series nor date data given. Boisduval misapplied this name of Herbst to a description and figures of tricularis Hübner (as per dos Passos, 1964, The Lepidopterists Society, Memoir No. 1, p. 9, under 610a).
- tomyris, Papilio Herbst, 1800. Natur. Bekan. Ausland. Insekten. Die Schmetter. 10: 102-104; plate 270, figs. 6-7. "in Preussen..." No sex, series nor date data given.

- tricularis, Argynnis Hübner. [Mid May 1821] - [31 Dec. 1821]¹¹. Samm. Exot. Schmetter. 2(?): no text; plate [19], figs. 1-4; p. [1] in Index, published later by Geyer. No sex, series nor date data given. Spelled trichlaris by Morris, Feb. 1862, Smithsonian Misc. Coll., p. 48, under no. 12.
8. BOLORIA EUPHROSYNE (LINNAEUS).
andersoni, Brenthis Dyar. Mar. 1904. Jour. New York Ent. Soc. 12 (1): 39. "One male, labelled, Kootenay, B[ritish]. C[olumbia]., from E. M. Anderson, who originally had three. Type. - No. 7735, U. S. National Museum". No date given.
argenticollis, P[apilio]. Retzius. 1783. De Geer... Genera and Species Insect.; p. 31, no. 13. Gives De Geer's name for euphrosyne Linnaeus, thus creating a synonym.
euphrosyne, P[apilio]. N[ympthalis]. [Phaleratus] Linnaeus. 1758. Syst. Nat. 10th. Ed. 1: p. 481, no. 142. "Habitat in Europa and America septentrionali". No sex, series nor date data given. Spelled euphrosine by Linnaeus, 1767, Syst. Nat., 12th Ed. 1(2): [1339].
morrisii, Brenthis Reakirt. [11 June 1866] - [13 Feb. 1867]⁶. Proc. Acad. Nat. Sci. Phila. [18] (3): 246-247, no. 21. ♂ and ♀ described. "Hab. - California. (Coll. Tryon Reakirt.)" No series nor date data given. Strecker, who later possessed Reakirt's collection, says (Lepid., Rhopal. and Heter., Indig. and Exot. Suppl. 3: 20, 1900): "1 ♂" which he considered to be euphrosyne Linnaeus.
princeps, P[apilio]. N[ympthalis]. [Phaleratus]. Linnaeus. 1758. Syst. Nat. 10th. Ed. 1: 481, under no. 142. Inadvertently created a synonym of euphrosyne; see that name for details.
9. BOLORIA FREIJA (THUNBERG).
browni, Clossiana freija Higgins. Sept. 1953. The Entomologist 86(9): 210, no. 9. "Holotype male. - Independence Pass, Pitkin Co [unt], 30th June, 1950. Allotype female. - Hall Valley, Park Co. Colo[rado]. 23rd June, 1950. Paratypes. - 10 males and 9 females in my collection". "The holotype and female allotype have been handed to Mr. Cyril dos Passos for inclusion in the collection of the Natural History Museum, New York."
freija, Papilio N[ympthalis]. Ph[aleratus]. Thunberg 10 Dec. 1791. D. D. Disser. Ent. Sist. Insecta Svec. (2): 34-36; plate 2, figs. 14 and 14. [♂ and ♀ described]. "Habitat in Vestrobothnia juxta flumina locis graminosis D. Mag. Libijeblad and in Lapponia D. Mag. Quenzel". No series nor date data given.
freya, Argynnis Godart. 1819. In Godart and Latreille in Latreille. Encycl. Méth. 9(1): 254, no. 37 (named in French); 9(1): 273, no. 37. Proposes new name for freija Thunberg. Cites Thunberg's description among others. "Elle habite le nord de la Suède and le sud de la Laponie."
gunderi, Brenthis freija Harper. 8 Sept. 1933. Pan-Pacific Ent. 9 (3): 99. "Holotype male, McCreary, Manitoba, Canada. May 22nd, 1932". "...type deposited in the Calif. Academy of Sciences at San Francisco, Calif. as an "indefinite loan" for safe keeping."
lapponica, P[apilio]. Nymph[alis]. Phal[eratus]. dia Esper. [1793]¹⁰. Die Schmetterlinge. Suppl. Theils I (pp. 9-60, plates 95-100): 21-22, no. 187; plate 97, fig. 3 ♂ described. "Der lappandisch P. Dia." No series nor date data given.

nabokovi, Boloria freija Stallings and Turner. 15 Jan. 1947. Canadian Ent. 78(7-8): 134-135; fig. 1. "Holotype: Male. Alaska Military Highway, July 23, 1943, Mile 102, North of Summit 2, Ravine, Elevation 6000 ft. . . Paratype: One male. Same data". "Holotype and paratype returned to the Museum of Comparative Zoology at Cambridge, Mass., from which we received the specimen on loan". "This... race... was collected along the Alaska-Military Highway in British Columbia."

natazhati, Brenthis Gibson. 10 Jan. 1920. Rept. Canadian Arct. Exped. 3(i): 21i-22i, 52i, 56i; plate 3, figs. 6 and 12; pl. 5, fig. 6. "Type, a male, in the Canadian National collection bearing the label "141st meridian, north of mount Natazhati, international boundary survey, elevation 8,600 feet, June 15, 1913... Paratypes, three males and two females from the same locality and bearing the same label". "Two specimens taken during the Canadian Arctic Expedition, namely at Bernard harbour, Northwest Territories, July 14, 1916, male and female... although somewhat rubbed are apparently this new species."

tarquinius, Melitaea Curtis. 1835. In J. Ross. Append. Narr. 2nd. Voy. Search North-West Pass. (Nat. Hist. Sect.); pp. lxxviii-lxix, no. 14. "... specimens were captured on the 10th of June, and between the 2d and 14th of July, 1830, they were abundant; in 1831 the first butterfly seen was of this species; this was the 10th of July, and on the 14th two more were taken". No sex, series nor locale data given.

10. BOLORIA FRIGGA (THUNBERG).

alaskensis, A[rgynnis]. frigga improba Lehmann. [16 Sept. 1913]¹².

In. A. Seitz, Grosser-Schmett. Erde 5(173): 424. Figured later on plate 87, col. c. "... ♀ received by Prof. Seitz from north-eastern Alaska (69° 40' N. Lat., 141° W. Long.)". No date given. A homonym of B. pales alaskensis Holland, Mar. 1900.

frigga, Papilio N[ymphalis]. Ph[aleratus]. Thunberg. 10 Dec. 1791 D.D. Dissert. Ent. Sist. Insecta Svec. (2): 33-34. "Habitat in Lapponiae sylvis, locis uliginosis Salice Lapponum repletis, Lilijeblad; Quenzel". No sex, series nor date data given.

gibsoni, Brenthis frigga Barnes and Benjamin. 8 Dec. 1926. Bull. Sou. Calif. Acad. Sci. 25(3): 92, no. 197d. "We select as Holotype ♂ a specimen from Barter Island, Northern Alaska, July 4, 1914, ex Coll. D. Jenness, and as Allotype ♀ the specimen figured by Gibson, the remainder of Gibson's series are designated paratypes." Applies the name to the specimens Gibson (Rept. Canadian Arct. Exped. 1913-18 3(i): 24i; plate 5, fig. 1) called "Brenthis frigga alaskensis Lehm." Gibson's series consisted of 3 ♂♂ and 4 ♀♀ from Alaskan locales (July dates in 1914) and 3 ♂♂ and 3 ♀♀ from Armstrong Point, Victoria Island, Northwest Territories, June 20 to July 11, 1916.

lehmanni, B[renthis]. frigga Holland. 10 Oct. 1928. Ann Carnegie Mus. 19(1) art. 3: 44. A new name for alaskensis Lehmann in Seitz which is a homonym of alaskensis Holland. See alaskensis Lehmann for data.

saga, Argynnis frigga Staudinger (Kaden Ms. name). Oct.-Dec. 1861. Ent. Zeitung Stettin 22(10-12): 350-351, under no. 16. "... aus

Labrador". "in der...Sammlung des Herr Direktor Kaden..."

No sex, series nor date data given.

sagata, Brenthis frigga Barnes and Benjamin. 25 June 1923. Canadian Ent. 55(6): 146. "A series of specimens from Alberta can remain as intermediates between saga and sagata. Type localities and number and sexes of types: Holotype, ♂, June 24, 1893; allotype, ♀, June 23, 1893; 8 ♂, 5 ♀ paratypes, June 23-24, 1893; all Hall Valley, Colorado, Wm. Barnes: 4 ♂ paratypes, "Colo." (Bruce); 1 ♀ paratype "Colorado".

11. BOLORIA IMPROBA (BUTLER).

improba, Argynnis Butler. Feb. 1877. Ent. Monthly Mag. 13(153): 206. "The first examples of this species...were presented to the British Museum in 1851 by Sir John Richardson, captured between 67 1/2 and 68°; they were worn... In 1855 a nearly perfect female example, of which I here give a description, was presented by Captain Collinson, of H. M. S. "Enterprise," and forms part of a collection of 100 Lepidoptera made in Winter Cove and Cambridge Bay." No date data given.

youngi, B[renthis]. Holland. Mar. 1900. Entomological News 11(3): 383-384, no. 9. "1 ♀, mountains between Forty-Mile and Mission Creeks, N. E. Alaska, June 20."

12. BOLORIA KRIEMELD (STRECKER).

kriemhild, Argynnis Strecker. [1878, after 9 Aug.] - [July 1879]¹³.

In Ruffner. Ann. Rept. Sec. War for 1878 2(3), append. SS: 1854; plate 1, figs. 5-6. "...this is the species which I have cited in my catalogue on p. 117 as Bellona var., there described from a single example received from Utah. The reception of other examples since from Arizona as well as the present ones from Rio Florida Colorado..." No sex nor date data given.

laurenti, Argynnis Skinner. 4 Dec. 1913. Entomological News 24(10): 430. "Described from eight specimens taken... at Silver Lake (Brightons), Utah, July 10th to 14th, 1889. Type in the collection of the Academy of Natural Sciences of Philadelphia." No sex data given.

lucki, Clossiana (emendatio) Reuss. 1 Apr. 1923. Societas Entomologica 38(4): 14 ♂ and ♀ described. "...aus Utah, Nord-Amerika". No date data. "1 ♂, 2 ♀♀ in coll. m." Original spelling: lücki.

13. BOLORIA NAPAEA (HOFFMANSEGG).

alaskensis, B[renthis]. pales Holland. Mar. 1900. Entomological News 9(3): 383, no. 6. "1 ♂, mountains between Forty-Mile and Mission Creeks, July 20..."

halli, Boloria pales Klots. 22 Mar. 1940. American Mus. Nov. No. 1054: 1-4. "Type Lot. - Holotype male, allotype female, 139 male paratypes and 57 female paratypes, vicinity of Green River Pass, Wind River Range, Sublette Co[unty]., Wyoming, July 18-31, 1939, collected by David Bigelow and the author. The holotype, allotype and a series of paratypes have been deposited in the collection of The American Museum of Natural History. The remaining paratypes are in the collections of Mr. Bigelow and the author. Series of them will be distributed to numerous museums."

napaea, [Papilio]. Hoffmannsegg. 1804. In Illiger. Mag. fur Insektenkunde 3: 196. Proposes a new name for [Papilio] isis Hübner

(Sammlung Europäischer Schmett. [Papiliones]: plate 7, figs. 38-39 and plate 110, figs. 563-564; [24 Dec. 1799] - [13 Apr. 1800]⁹) which is an homonym of Papilio D. F. isis Thunberg, 10 Dec. 1791, D.D. Dissert. Ent. Sist. Insecta Svec. (2): 31. Hübner illustrated both the ♂ and ♀. Hübner in his text (published after the plate) says: "Heim. Die Alpen des Tyrols." Hübner gave no series nor date data.

nearctica, Boloria pales arsilache Verity, 12 Oct. 1932, Deutsche Ent. Zeitschrift "Iris" 46(3): 104 and 108. Applies the name to the "pales Schiff." described by Lehmann in Seitz, Die Gross-Schmetter. Erde 5: 423, [16 Sept. 1913] where the ♂ and ♀ are described but no series nor date data is given. "...north-eastern Alaska (69° 40' N. Lat. and 141 W. Long.)"

reiffi, Boloria Reuss, 22 Dec. 1925, Internat. Ent. Zeitschr. 19 (36): cols. 279-280. "Nur ein exemplar aus Britisch-Columbien, die Type ♂, in Koll. m." No date given.

14. BOLORIA PALES ([DENIS AND SCHIFFERMULLER]).
pales, P[apilio]. [Denis and Schiffermuller]. 1775 [8 Dec.]³. Ankünd. Syst. Werkes Schmetter. Wienergegend; pp. 176-177, no. 8. Locale: [Wienergegend] (from title of work). No sex, series nor date data given.

15. BOLORIA POLARIS (BOISDUVAL).
americana, Argynnis polaris Strand, 1905, Rept. 2nd. Norwegian Arctic Exped. "Fram" 1898-1902 1(3): 10-11, no. 3. "Es liegen 8 Exemplare vor, die folgender Orte gesammelt wurden: Havnen, Rice Strait (Ellesmere Ld.) 29/6 99; ibid. 25/7 99; Havnefjorden (Jones Sd.) 22/7 1900; Gaasefjorden (Ellesmere Ld) 30/6 02; die Westseite von Gaasefjorden 6/7 1902 (Baumann). No sex data given.

gronlandica, Argynnis chariclea [Skinner]. 1 Mar. 1892. Entomological News 3(3): 49, nos. 9-10; plate 2, figs. 9-10. Locale: [Greenland]. (from plate explanation text). In a later reference by Skinner and Mengel (Proc. Acad. Nat. Sci. Phila. 44: 157, 1892) indicate the West Coast of Greenland at possibly any or all of the following: McCormick Bay, Herbert Island and Disco. No sex nor date data given. The later reference says: "...a few specimens..."

polaris, Argynnis Boisduval. [22 Nov. 1828]¹⁴. Europ. Lepid. Ind. Meth.; pp. 15-16. "...Cap Nord..." No sex, series nor date data given.

16. BOLORIA SELENE ([DENIS AND SCHIFFERMÜLLER]).
albequina, B[renthis]. Holland, 10 Oct. 1928, Ann. Carnegie Mus. 19(1) art. 3: 40-41, no. 6. "...based upon eight specimens, seven males and one female, collected at White Horse Pass, Yukon Territory, .. Type ♂, ♀ allotype, and 6 ♂ paratypes in Holland Collection". The only female was considered aberrant and was named baxteri.
atrocostalis, Argynnis Huard, Dec. 1927, Le Naturaliste Canadian 54(6): 131, no. 8, ♂ and ♀ described. "Le couple capturé à Chicoutimi, [Canada] en 1881." No date data given.
baxteri, B[renthis]. albequina Holland, 10 Oct. 1928, Ann. Carnegie Mus. 19(1) art. 3: 40-41, no. 6 (in part). See albequina Holland for data.

- gunderana, B[renthis]. selene myrina Forbes, Sept. 1960. Lepid. New York and Neighboring States (4): 150, under no. 1. Forbes attributes the name to Dyar but no publication by Dyar has been located. No series, sex, date nor locale data is given.
- jenningsae, B[renthis]. myrina Holland, 10 Oct. 1928. Ann. Carnegie Mus. 19(1) art. 3: 36, a under no. 1. ♂ described. "... taken... at Jellicoe, on Thunder Bay, Ontario [Canada]. The specimen is in the Carnegie Museum, Acc. No. 5921. "No date data given.
- marilandica, Brenthis selene Clark, 15 Sept. 1941. Jour. Washington Acad. Sci. 31(9): 384. "Type. - From the boggy pasture on the south side of the road from the Beltsville, M[aryland], railway station to the Department of Agriculture experiment farm, collected... on July 6, 1929 (U. S. N. M. no. 55470...). "In a previous article (Bull. U. S. Nat. Mus. No. 157: 104; plate 3, figs. 5-6; 1932), he speaks of a series of 16 specimens from Beltsville but gives no sex here or later for the type.
- myrina, Pap[ilio]. Nymph[alis]. Phaler[atus]. Cramer. [1777]³. Uitland, Kapellen Voorkom. Drei Waereld-Deelen Asia, Africa en America 2(16): 141 and 150; plate 189, figs. B-C. "On l'a prise dans l'Amerique Septentrionale, à la Nouvelle-York." No series, date nor sex data given. Spelled myrinna by Gruber; Jenaische Zeitschrift 17: 479; plate 8, figs. 34-35; 11 June 1884. Spelled myrinus Herbst; Natursyst. Ins. Schmett. 9: 178-179; plate 255, figs. 3-4; 1798 (as per Scudder).
- myrissa, Argynnis Godart. [1824]¹⁵. In Godart and Latreille in Latreille. Encycl. Méth. 9(2): 806 (and 253, 268). Proposes new name for myrina (Fabr., Cramer, Herbst).
- nebraskensis, B[renthis]. myrina Holland, 10 Oct. 1928. Ann. Carnegie Mus. 19(1) art. 3: 36-37, no. 1c. "For many years I have had in my possession four specimens, unfortunately all of them males, collected for me in Dodge County, Nebraska..." No date data given. Spelled nebrascensis by Forbes; Sept. 1960; Lepid. New York and Neighbor. States (4): 150, under no. 1.
- nivea, Brenthis myrina Gunder. 30 July 1928. Canadian Ent. 60(7): 163; plate a, fig. 4. "Data: Holotype ♂ (fig. 4)... Staten Island, N[ew]. Y[ork]... May 28, 1900. In Author's coll."
- nubes, B[renthis]. m[yrina]. Scudder. 1 Mar. 1889. Butt. East. U.S. and Canada 1(5): 595-596. "In the Museum of Comparative Zoology is a male from Sanborton, N[ew]. H[ampshire]... collected by W. Blaney on August 15, 1884..." He speaks of two other specimens with suffused black markings but these have no standing.
- selene, P[apilio]. [Denis and Schiffermüller]. 1775 [8 Dec.]³. Ankünd. Syst. Werkes Schmetter. Wienergegend; p. 321, no. 11. Also see pages 176-177. Locale: [Wienergegend] (from title of work). No sex, series nor date data given.
- serratimarginata, Brenthis myrina Gunder. 7 Jan. 1926. Entomological News 37(1): 7, no. 10; plate 1, fig. 10. "Data: Holotype ♂... (Author's Coll.), Vernon, British Columbia, Canada. August 12, 1904."
- terraenovae, B[renthis]. myrina (emendatio) Holland, 10 Oct. 1928. Ann. Carnegie Mus. 19(1) art. 3: 36, no. 1b. "In the collec-

tion of Theodore L. Mead is a series of male specimens taken by him in Newfoundland". No date data given. Name originally spelled: terrae-novae.

tollandensis, Brenthis myrina Barnes and Benjamin, 5 Feb. 1925.

Entomological News 36(2): 44. "Type locality: Tolland, Moffat County, Colorado, altitude approximately 10,000 ft. Number and sexes of types: Holotype ♂; Allotype ♀; 5 ♂, 7 ♀ Paratypes; ... July, 1924. Types in: Barnes Collection."

17. BOLORIA TITANIA (ESPER).

boisduvalii, Argynnis Duponchel (Sommer Ms. name). [1832]¹⁶. In

Godart. Hist. Nat. Lepid. ou Pap. de France, Suppl. to vols. 1-2(?): 127-128; plate 20, no. 4. "Elle habite les contrées les septentrionales de l'Europe". No sex, series nor dates given. Spelled boisduvali by Barnes and McDunnough, Feb. 1917, Check List Lepid. Boreal America; p. 8, no. 193a.

grandis, Brenthis chariclea Barnes and McDunnough, 12 July 1916. Canadian Ent. 48(7): 223. "Types - A long series of ♂'s and ♀'s from Hymers, Ont[ario]. [Canada] (Aug. 1-15, Dawson) in Coll. Barnes."

helena, Argynnis W.H. Edwards, Feb. 1871. Trans. American Ent. Soc. 3(3-4) sign. 34: 268 only. ♂ and ♀ described. "Taken by Mr. Mead in Colorado." No sex, series nor date data given.

ingens, Brenthis helena Barnes and McDunnough, 15 May 1918. Contrib. Nat. Hist. Lepid. N. Amer. 4(2): 71 and 180; pl. 11, figs. 5-6. "Our type series consists of 4 ♂'s and 6 ♀'s, two of the latter from Sheridan, Idaho; three of the paratypes are in the Collection of Prof. E. T. Owen..." The description is opened with the following: "In the Yellowstone Park there occurs a race of helena..." No date data given.

labradorensis, Brenthis chariclea oenone Gunder. 30 July 1928. Canadian Ent. 60(7): 163; pl. A, figs. 5 and 5a. "...Holotype ♂... Labrador, no date. In the Barnes coll., Decatur, Ill..."

martini, Brenthis helena ingens Gunder. 30 June 1934. Canadian Ent. 66(6): 127-128. "Holotype ♂... Teton trail, Teton Mts., Teton County, Wyoming (just south of the ingens type locality), July 8, 1931. Type in Author's coll."

montinus, Argynnis Scudder. Apr. 1863. Proc. Essex Inst. 3(?):

166, no. 32. ♂ and ♀ described. "This species is found on the lower half of barren summits of the White Mountains, N[ew] H[ampshire]. I have taken only a few specimens from July 21st to Aug. 18th around bushes and in the road." Spelled montina by Klots, 1951, Field Guide to the Butterflies, pp. 91, 112, and 345.

rainieri, B[renthis]. chariclea Barnes and McDunnough, 15 Apr.

1913. Contrib. Nat. Hist. Lepid. N. Amer. 2(3): 96-97 and 148; plate 2, figs. 1-4. "Habitat. Mt. Ra[i]nier, Wash[ington]. (July 23-31) (McDunnough), 7 ♂, 7 ♀. Types, Coll. Barnes." Spelled ranieri by the authors on page 148.

titania, P[apilio]. N[ymphalis]. Ph[aleratus]. Esper. [1793]¹⁰. Die Schmetterlinge. Suppl. Theils 1(?): 58-59, no. 197; pl. 103, fig. 4. ♀ described. "...aus Sardinien..." No date given.

LIST OF SPECIES AND LOWER CATEGORY NAMES
USED OR AVAILABLE FOR ARGYNNIS

1. ARGYNNIS APHRODITE (FABRICIUS).
alcestis, Argynnis W.H. Edwards. Dec. 1876. Trans. American Ent. Soc. 5(?) sign. 37: 289-291. ♂ and ♀ described. "... found in Northern Illinois, Iowa and Colorado". No date nor series data given. Type locality "fixed" (dos Passos and Grey, p. 8, 1947) as Galena, Jo Daviess County, Illinois.
- aphrodite, P[apilio]. N[ymphalis]. P[haleratus]. Fabricius. 1787 [after 3 Feb.]¹⁷. Mant. Ins. 2: 62, no. 590. "Habitat in America meridionali..." No date, sex nor series data given. Type locality "fixed" (dos Passos and Grey, p. 6, 1947) as New York City, New York County, New York. Spelled aphrodita by Fabricius; Index Alphabeticus... Ent. Syst.; p. 119, no. 443; 1796.
- bakeri, Argynnis aphrodite Clark. 1932 [13 Feb.]¹⁸. Bull. United States Nat. Mus. No. 157: 276; plate 19, figs. 1-2. "Waynesburg, Ohio, July 2, 1937." No sex nor series data given.
- bartschi, Argynnis cybele Reiff. Dec. 1910. Psyche, Jour. Ent. 17 (6): 252-255; text fig. 1; plate 13, 2 unnumbered figs. "... captured in West Roxbury, Mass[achusetts]., during the first week of July, 1907". "Type 1 ♂ in the collection of the Bussey Institution."
- byblis, Dryas aphrodite Barnes and Benjamin. 8 Dec. 1926. Bull. Sou. California Acad. Sci. 25(3): 91, no 157d. "Type locality: White Mts., Ariz[ona]. Number and sexes of types: Holotype ♂, Allotype ♀, 4 ♂ 1 ♀ Paratypes, no dates."
- columbia, Argynnis Henry Edwards. 17 Dec. 1877 - [Nov. 1878]¹⁹. Pac. Coast Lepid. No. 26: [1]. "...the above description being made from four ♂♂ taken by Mr. Crotch, at Lahache, near the Alaskan border of British Columbia." No date data given. The authorship here is in question, see claim of W. H. Edwards, below.
- columbia, Argynnis W.H. Edwards (H. Edwards Ms. name). Dec. 1877 [Feb. 1878]²⁰. Field and Forest 3(6): 102-103. "From a large number of examples taken by the late G. R. Crotch at Lakes Lahache and Ouesnelle, British Columbia, of which 10 ♂ and 4 ♀ are now before me." No date data given. The authorship here is in question, see claim of H. Edwards, above.
- cypris, Argynnis W.H. Edwards. 21 Apr. 1886. Canadian Ent. 18(4): 62-64. ♂ and ♀ described. "Found from Arizona to Montana. Taken in Colorado in 1871 by Mr. Mead; by Mr. Morrison, in his trips to So. Colorado and to Arizona; by Mr. Nash and Mr. Bruce in Colorado. It seems to be an abundant species in the latter state." No series data given. "In 1884, I received eggs... and the females that laid them. From these I bred the larvae and got three imagoes, one male and two females, in 1885." Type locality "fixed" (dos Passos and Grey, p. 9, 1947) as Bighorn, Treasure County, Montana. A homonym of Argynnis cypris Meigen [1828]²¹, Syst. Beschreib. Europ. Schmett. 1(?): 59-60, no. 13.
- ethne, Argynnis Hemming. Dec. 1933 [before 19th]²². Entomologist 66(847): 276, no. 10. Proposes a new name for Argynnis cypris

23, 1900... No. 632 in the Canadian National Collection. Allotype - ♀, Calgary, Alta., July 12, 1900... in the Canadian National Collection. Paratypes - 4 ♂, 12 ♀, Calgary, Alta., various dates; 1 ♀, Lethebridge, Alta., Aug. 7... 2 ♂, 5 ♀, Waterton Lakes, Alta... various dates in July."

callippe, Argygnis Boisduval. 1852 [Aug.]²⁴. Ann. Soc. Ent. France. 2nd. Ser. 10(2): 302, no. 43. ♂ and ♀ described. "Vole en juin au bord des forets." Article Title indicates "Californie" as habitat. No date nor series data given. Type locality "fixed" (dos Passos, p. 14, 1947) as San Francisco, San Francisco County, California. Spelled calippe by Gunder, p. 9, Entomological News, vol. 36, 1925.

comstocki, Argygnis calippe Gunder. 5 Jan. 1925. Entomological News 26(1): 8-9, no. 10; plate I, figs. 6-7. "Data: Holotype ♂ (Author's Coll.), Los Angeles, Los Angeles County, California, May 26, 1919. Allotype ♀ (Author's Coll.), Los Angeles, Los Angeles County, California, May 20, 1920. Paratypes 11-♂ and 5-♀, same locality and similar dates, in collections of Mr. Chas. Ingham and author. Paratypes and topotypes will be deposited with the Southwest Museum, and the Academy of Sciences, San Francisco, California."

creelmani, Argygnis comstocki Gunder. 30 June 1934. Canadian Ent. 66(6): 127. "Holotype - ♂, expanse 48 mm.; East San Diego, California, June 13, 1933. Type in Author's coll."

elaine, Speyeria callippe dos Passos and Grey. 14 Sept. 1945. Amer. Mus. Novitates. No. 1297: 5; figs. 13-14. "Type Material: The holotype male and allotype female are from Butte Falls, Oregon, May 21, 1931 (ex J. D. Gunder collection). There are 70 paratypes from Jackson County, southern Oregon, as follows: 6 pairs, Ashland, June (T. B. Blevins, Jr., collection); 2 males, Hyatt Lake, June 29-30 (D. B. Stallings collection); 17 males and 4 females, Butte Falls, May 11-21 (L. P. Grey collection); 3 males and 6 females, Roxy Ann, near Medford, June 30 - July 12 (L. P. Grey collection); 4 males, Butte Falls, May 19-23 (C. F. dos Passos collection); 2 pairs, Siskiyou Summit, June 28-29, 1939 (M. Doudoroff, C. F. dos Passos collection); 8 males and 4 females, Butte Falls, May 17-June 24 (ex J. D. Gunder collection); 2 females, Medford, May 30-June 6 (ex J. D. Gunder collection); 1 male and 1 female, Butte Mountains, July 12-13 (ex W. C. Wood collection); 1 female, Siskiyou Pass, June (ex J. D. Gunder collection); 1 female, Keene Creek, June 24 (G. Malcomb, ex J. D. Gunder collection). All of the specimens were collected by W. F. Lawrence, unless otherwise credited. The holotype, allotype, and the 18 paratypes ex J. D. Gunder and ex W. C. Wood collections are in the American Museum of Natural History. The other paratypes are in the collections of T. B. Blevins, Jr., D. B. Stallings, as above noted, and the authors."

gallatini, Argygnis nevadensis McDunnough. 3 June 1929. Canadian Ent. 61(5): 106-107. "Holotype. - ♂, Elkhorn Ranch, Upper Gallatin Canyon, Mont[ana], Aug. 1, (J. McDunnough); No. 2954 in the Canadian National Collection, Ottawa. Allotype. - ♀, same locality, Aug. 3. Paratypes. - 9 ♂, same locality, Aug. 1, 6."

Edwards, 21 Apr. 1886 which is a homonym of Argynnis cypris Meigen [1828] 21. See Argynnis cypris Edwards for specimen data.

hughi, Speyeria aphrodite Clark and Clark. 20 Dec. 1951. Smithsonian Misc. Coll. 116(7): 126. Only ♂ described. No date nor locality data given. In a previous article where A. H. Clark used the name (Nomen nudum), he said, "... only known from a single bog in Essex, Mass[achusetts]."

manitoba, Argynnis Chermock and Chermock. 30 Apr. 1940. Canadian Ent. 72(4): 83. "Holotype - ♂, July 29, 1934, Sand Ridge, Manitoba [, Canada]. Allotype - ♀, August 5, 1934, Sand Ridge, Manitoba. Paratypes - 1 to 150, all from the same locality". "All the holotypes will be deposited in the Canadian National Collection and the allotypes in the Carnegie Museum" (from opening paragraph of article containing description).

mayae, Argynnis aphrodite cypris Gunder. 31 Dec. 1932. Canadian Ent. 64(12): 279. "Holotype - ♂... Sand Ridge, Bener Dam Lake, near Kelwood, Man[itoba]., Can[ada]., Sept. 10, 1931. Allotype - ♀... same location, Aug. 17, 1930. Types in Author's coll...."

suffusa, Argynnis alcestis Wolcott. 1 Mar. 1916. Entomological News 27(3): 97-98; pl. 4, fig. 5. "This form is described from one male specimen collected in a bog south of Grand Rapids, Michigan, in August, 1897."

whitehousei, Argynnis Gunder. 31 Dec. 1932. Canadian Ent. 64(12): 279-280. "Holotype - ♂... allotype - ♀... Jaffray, B[ritish]. C[olumbia]., Aug. 5, 1929. Paratypes - 2 ♂ and 2 ♀, same locality and dates, one pair deposited in the Canadian National Collection at Ottawa, Ont., and one pair placed in the U.S. National Museum (Barnes Coll.), Washington, D. C. Types in Author's coll., including a fine lot of topotypes and others from Cranbrook, B. C., which is nearby."

winni, Argynnis aphrodite Gunder. 31 Dec. 1932. Canadian Ent. 64(12): 278-279. "Holotype - ♂... St. Calixte de Kilkenny, Que[bec]. (about 40 miles from Montreal), July 13, 1931. Allotype-♀... Shawbridge, Que., Aug. 4, 1930. Paratypes - 3 ♂ and 3 ♀, similar localities and dates, one pair deposited in Canadian National Collection, Ottawa, Can., and one pair deposited in U. S. National Museum (Barnes Coll.), Washington, D. C. Types in Author's coll. including a series of topotypicals."

2. ARGYNNIS ATLANTIS W. H. EDWARDS.

arizonensis, Argynnis ?aphrodite Elwes. Dec. 1889. Trans. Ent. Soc. London for 1889 (4): 546. Cites Mead in Wheeler Rept., p. 752, 1875. "... was taken... in Arizona, ... occurs also in Colorado though it is very rare" (from Mead). No date, sex nor series data given. Type locality "fixed" (dos Passos and Grey, p. 19, 1947) as Rocky Can[y]on, [? Chochise County], Arizona.

atlantis, Argynnis W. H. Edwards. [1862, Feb. - 25 Apr.] 6. Proc. Acad. Nat. Sci. Philadelphia [14] (1-2): 54-55. ♂ and ♀ described. "This species seems to be limited to mountainous districts of the Northern States and to parts of British America. In the Catskill Mountains, near the Mountain House, I found it abun-

dant, the past season (1861). I have received it from the White Mountains, from Williamstown, Mass[achusetts]., and from Lake Winnipeg... from near Hudson's Bay... the specimens from the White Mountains and Hudson's Bay are diminutive in size. There is also a specimen in the cabinet of the late Dr. Harris... taken... on the north side of Lake Superior." No date nor series data given.

beani, *Dryas atlantis* Barnes and Benjamin, 8 Dec. 1926. Bull. Sou. California Acad. Sci. 25(3): 92, no. 160b. "Type locality: Banff, Al[ber]ta. Number and sexes of types: Holotype ♂, 8-15 Aug., Allotype ♀, 8-15 Aug. 3♂ 3♀ Paratypes, 8-15 Aug., 15-23 Aug., and no date."

canadensis, *Argynnis atlantis* dos Passos, 4 May 1935. Canadian Ent. 67(4): 85-87. "18 ♂ 34 ♀, July 20- September 12. Holotype - ♂ July 20, 1934, Doyles Station, Newfoundland. Allotype - ♀, August 8, 1934, Doyles Station, Newfoundland. Paratypes - Six pairs, all from Doyles Station, Newfoundland, in 1934. (4 ♂ July 20, 2 ♂ August 3, 4 ♀ August 8, 1 ♀ August 18, 1 ♀ Aug. 23). The types have been deposited with the American Museum of Natural History and one pair of paratypes with the Canadian National Museum and Los Angeles Museum. The remainder are in the author's collection. A ♂ and ♀ in the collection of the Carnegie Museum, taken in copulation (pair No. 1) on July 21, 1934, by Dr. Brooks on Wood Road near Camp 31, Lomond, four miles south of Bonne Bay, west coast of Newfoundland, are also designated paratypes."

chemo, *A[rgynnis]. a[tlantis]*. Scudder, 1 Feb. 1889. Butt. East. United States and Canada 1(4): 573-574. "...female... taken July 1, 1887, at Lake Chemo, ten miles northeast of Bangor, M[aine]." Also mentions a slightly suffused male from the White Mountains, [New Hampshire].

chitone, *Argynnis* W. H. Edwards, May 1879. Canadian Ent. 11(5): 82. ♂ and ♀ described. "From several examples... taken in Southern Utah and Arizona." No date data given. Type locality "fixed" (dos Passos and Grey, p. 19, 1947) as Cedar Breaks National Monument, Iron County, Utah.

cornelia, *Argynnis* W. H. Edwards, 28 Apr. 1892. Canadian Ent. 24 (5): 106-107. ♂ and ♀ described. "This species flies with *Electa* and *Hesperis*, at Ouray and Manitou, Colorado, and in the adjacent districts, where it has been taken abundantly by Prof. Owen. Mr. Bruce has taken it also at Crested Butte in the Ouray region". "Described from nearly 40 examples sent me by Prof. Owen and Mr. Bruce." No date data given. Type locality "fixed" (dos Passos and Grey, p. 20, 1947) as Ouray, Ouray County, Colorado.

cottlei, *Argynnis* J. A. Comstock, 15 Nov. 1925. Bull. Sou. California Acad. Sci. 24(3): 64-65. "Type, ♀ near Alturas, Modoc Co [unty]., Calif[ornia]. No date given. In the collection of Mr. J. E. Cottle..."

dennisi, *Argynnis lais* Gunder, 31 Dec. 1927. Canadian Ent. 59(12): 287, no. 21; plate B, figs. 21, 21a. "Data: Holotype ♂... Beulah, Man[itoba]., Can[ada]... June 28, 1910. To be placed in the National Coll. at Ottawa..."

dodgei, Argynnis Gunder, 10 Sept. 1931. Bull. Sou. California Acad. Sci. 30(2): 46. "Holotype ♂... July 10, 1930; allotype ♀... July 17, 1931. Diamond Lake, Douglas Co[unty]., Oregon. Type in Author's coll. Paratypes - 10 ♂, and 3 ♀; same place and dates. One pair deposited in the Canadian Nat. Coll. at Ottawa and one pair in the Nat. Museum (Barnes Coll.) at Washington."

dorothea, Speyeria atlantis Moeck, 13 June 1947. Entomological News 58(3): 73-75. "Type Material: A long series of dorothea was collected by the author on Sandia Peak (Sandia Peak is in extreme southeastern Sandoval County bordering upon Bernalillo County, some fifteen miles northeast of and overlooking Albuquerque), Sandia Mountains, New Mexico, July 13 to 15, 1946, at elevations ranging from six to over ten thousand feet. The specimens were taken from the very peak to two-thirds of the way down the mountain, along the winding road which leaves Highway 44 and runs thence to the tip in a general southwesternly direction. The holotype and allotype female were taken in copula, July 15, at about 7,000 feet elevation. They have been deposited in the American Museum of Natural History, New York City. Of the type catch mentioned above, 100 males and 100 females are designated paratypes which are in the author's collection; a number of them will be distributed to various museums and individuals."

electa, Argynnis W. H. Edwards, Mar. 1878. Field and Forest 3(9): 143-144. ♂ and ♀ described. "From 12 ♂ 4♀ received from Colorado. Several of these were taken in the north of that state by Mr. Mead in 1871, and I have until recently been undecided respecting them, but others, fresh and uninjured specimens, received from Mr. Morrison, and taken in the South in 1877, leaves no doubt in my mind as to the distinctness of this species." No date data given. Type locality "fixed" (dos Passos and Grey, p. 20, 1947) as Rocky Mountain National Park, Colorado.

greyi, Argynnis atlantis Moeck, 22 May 1950. Entomological News 61(3): 61-64. "Type Material: The holotype male was taken by the author in Lamoille Canyon, Ruby Mountains, Elko County, Nevada, on July 24, 1949, at an elevation of about 8,500 feet. The allotype female was taken in the same valley on July 27, at an elevation nearer 8,000 feet. There are 21 paratypes, as follows: 10 males and 3 females taken in, near, or above Lamoille Canyon, ranging in elevation from 7,000 to 10,000 feet; 4 males and 3 females taken along the snow of glaciers, close to 10,000 feet, above Angel Lake, East Humboldt Range, Elko County, Nevada on July 29, 1946; and 1 male at the Angel Lake area on July 29, 1949."

helenae, Speyeria (Speyeria) atlantis dos Passos and Grey. [Before 12 Mar. 1957]²². Jour. New York Ent. Soc. 63(in 1): 95-96. Propose new name for Argynnis lais W. H. Edwards, 17 Jan. 1884, which is a homonym of Arg. lais Scudder, Mar. 1875, (see Boloria). See lais W. H. Edwards for details.

hesperis, Argynnis W. H. Edwards. [9 May 1864]⁷. Proc. Ent. Soc. Philadelphia 2(4): 502-503. Only ♂ described. "From the Rocky Mountains." No date nor series data given. Type locality "fixed"

(dos Passos and Grey, p. 19, 1947) as Turkey Creek Junction, Jefferson County, Colorado.

hollandi, *Argynnis atlantis* Chermock and Chermock, 30 Apr. 1940. Canadian Ent. 72(4): 82-83. "Holotype - ♂, July 24, 1934, Riding Mountains, Manitoba [, Canada]. Allotype - ♀, July 16, 1937, same locality. Paratypes - 1 to 550, Riding Mountains, and Sand Ridge, Manitoba". "All the holotypes will be deposited in the Canadian National Collection and the allotypes in the Carnegie Museum." (from preliminary paragraph of article containing this description).

hutchinsi, *Argynnis atlantis beani* Gunder, 31 Dec. 1932. Canadian Ent. 64(12): 280. "Holotype - ♂... Twp. 2N. Range 1W., Jefferson County, Mont[ana], July 21, 1929. Type in Author's coll."

irene, *Argynnis* Boisduval. [1869, before 1 Nov.]⁸. Ann. Soc. Ent. Belgique 12: 59-60, in no. 53 (in part). "Cette Argynne [egleis, of which he considered irene a variety] est très comme dans lieux incultes et aux bords des forêts, dans l'intérieur de la Californie." No sex nor date data given. He speaks of having compared more than 100 examples (composed of egleis and irene). Type locality "fixed" (dos Passos and Grey, p. 20, 1947) as Massack, Plumas County, California.

lais, *Argynnis* W.H. Edwards, 17 Jan. 1884. Canadian Ent. 15(11): 209. "From several examples, male and female, taken at Red Deer River..." No date data given. Type locality "fixed" (dos Passos and Grey, p. 20, 1947) as Edmonton, Alberta [, Canada]. A homonym of Arg. lais Scudder, Mar. 1875, (see Boloria).

lurana, *Speyeria atlantis* dos Passos and Grey, 14 Sept. 1945. Amer. Mus. Novitates, No. 1297: 8-9; figs. 23-24. "Type Material: The type series is from the Black Hills of South Dakota. The holotype male and the allotype female are from Harney Peak, June 25, 1939 (A. C. Frederick, ex L. P. Grey collection). There are 32 paratypes as follows: 10 males and 5 females, same data as holotype; 10 males, Spearfish Canyon, near Lead, July 1, 1939 (A. C. Frederick, L. P. Grey collection); 5 males and 2 females, Custer, 1928 (C. F. dos Passos collection). The holotype, allotype, and a series of paratypes are in the American Museum of Natural History. The other paratypes are in the collections of the authors."

nausicaa, *Argynnis* W.H. Edwards, Oct. 1874. Trans. American Ent. Soc. 5(?) signs. 13-14: 104-105. "From 2 ♂, 1 ♀, taken by Mr. Henshaw, August 21, 1874, at Rocky Canon, Arizona."

nikias, *Argynnis* Ehrmann, 15 May 1917. The Lepidopterist, Offic. Bull. Boston Ent. Club 1(7): 55-56, ♂ described. "Habitat; Temez Springs, New Mexico. Types in my collection." No series nor date data given. Spelled nickias by dos Passos, Canadian Ent. 67: 86, 1935.

sehllbachi, *Speyeria atlantis* Garth, 20 June 1949. Bull. Sou. California Acad. Sci. 48(1): 1-4; figs. 1-4. "Type material: Male holotype, AHF [Allen Hancock Foundation] No. 471, and female allotype, AHF No. 471a, from Neal Springs, North Rim, Grand Canyon National Park, Coconino County, Arizona, 8,175 feet,

- July 5, 1947, collected by John S. Garth, Allen Hancock Foundation survey party. Twenty paratypes as follows: "[10 ♂ and 10 ♀, Grand Canyon areas, July 5 - Aug. 19, 1939 - 1947].
- tetonia, Speyeria atlantis dos Passos and Grey. 14 Sept. 1945. Amer. Mus. Novitates. No. 1297: 9-10; figs. 27-28. "Type Material: The type series is from the Teton Mountains region, Wyoming. The holotype male is from the Teton Mountains, July 11, 1931 (ex J. D. Gunder collection), and the allotype female is from the same locality, June 25, 1931 (ex J. D. Gunder collection). There are 38 paratypes as follows: 1 pair, same locality, June 29 - July 18; 2 males and 3 females, Moose Post Office, Jackson Hole, July 9-August 3 (A. B. Klots, the American Museum of Natural History); 1 male, Jackson, 6000 feet, July 13-17, 1920 (the American Museum of Natural History); 2 males and 4 females, Moose Post Office, Jackson Hole, 6000 to 7000 feet, July 15-August 3, 1929 (A. B. Klots, C. F. dos Passos collection); 8 males, Teton Mountains, July 1-21, 1943, and 8 pairs, Jackson Hole, July 14-August 9, 1937 (L. P. Grey collection)."
- viola, Speyeria atlantis dos Passos and Grey. 14 Sept. 1945. Amer. Mus. Novitates. No. 1297: 10; figs. 29-30. "Type Material. The type series is from the Sawtooth Mountains, Idaho. The holotype male is from Trail Creek, 7400 feet, July 11, 1931, and the allotype female is from Camp Creek, August 9, 1931 (C. W. Herr, ex J. D. Gunder collection). There are 23 paratypes as follows: 2 males, same data as holotype; 5 males and 1 female, Camp Creek, July 9; 2 males and 3 females, Deadwood Creek of Payette River, Boise County, 6800 feet, July 18; 2 females, Deadwood Summit, July 18; 1 male, Park Canyon, 7500 feet, July 10; 1 male, Wood River, July 17; 1 male, Summit Creek, 7800 feet, July 13; 1 male, Kane Creek, 8500 feet, July 8 (all preceding, ex J. D. Gunder collection); 3 males and 1 female, Custer County, July 18 - 21, 1933 (L. P. Grey collection). The holotype, allotype, and a series of paratypes are in the American of Natural History. The other paratypes are in the collections of the authors."
- wasatchia, Speyeria atlantis dos Passos and Grey. 14 Sept. 1945. Amer. Mus. Novitates. No. 1297: 8; figs. 25-26. "Type Material: the holotype male and the allotype female are from Payson Canyon, Payson, Utah, July 16, 1932 (L. D. Pfouts, ex J. D. Gunder collection). There are 44 paratypes as follows: 8 pairs, same locality and collector, July 15-28 (ex J. D. Gunder collection); 13 males and 7 females, July 3-29, same locality and collector (L. P. Grey collection); 4 pairs, same locality, July 9-29 (T. Spalding, C. F. dos Passos collection). The holotype, allotype, and a series of paratypes are in the American Museum of Natural History. The other paratypes are in the collections of the authors."
3. ARGYNNIS CALLIPPE BOISDUVAL.
- baroni, Argynnis liliana W. H. Edwards. [11 Mar. 1881]23. Trans. American Ent. Soc. 9(1) signs. 1: 2-3. ♂ described. No date nor series data given. Locality: ? North California.
- calgariana, Argynnis nevadensis McDunnough. 29 Feb. 1924. Canadian Ent. 56(2): 42. "Holotype - ♂, Calgary, Al[ber]ta., June

brought to notice by Mr. Mead, who took a single male in perfect condition at Turkey Creek Junction, in Colorado in 1871. Subsequently a female was brought in by the Hayden Yellowstone Expedition, taken the same season. "Type locality "fixed" (dos Passos and Grey, p. 16, 1947) as Turkey Creek Junction, [Jefferson County], Colorado. Spelled meadi by Holland, p. 99, Butt. Book, rev. ed., 1931.

nevadensis, Argynnis W. H. Edwards. Jan. 1870. Trans. American Ent. Soc. 3(1) sign. 2: 14-15. "From 1 ♂, 1 ♀, in the collection of Henry Edwards, Esq., San Francisco. Taken in the valleys of the Sierra, near Virginia City, in 1869.

rupestris, Argynnis Behr. Dec. 1863. Proc. Calif. Acad. Nat. Sci. 3(1) sign. 6: 84, no. 3. "...its inhabiting the steep rocky declivities characterizing the lower part of the Sierra. The specimens were collected... at a moderate elevation above the sea." No sex, series nor date data given, Type locality "fixed" (dos Passos and Grey, p. 15, 1947) as Trinity Center, Trinity County, California.

semivirida, Argynnis nevadensis McDunnough. 29 Feb. 1924. Canadian Ent. 56(2): 42-43. "Holotype - ♂, Aspen Grove, B[ritish]. C[olumbia]. July 14, 1922, (P. N. Vroom); No. 633 in the Canadian National Collection. Allotype - ♀, same data, in the Canadian National Collection. Paratypes - 1 ♂, 2 ♀, same data; 1 ♂, June 28, in the Canadian National Collection."

sierra, Speyeria callippe dos Passos and Grey. 14 Sept. 1945. Amer. Mus. Novitates. No. 1297: 5-6; figs. 15-16. "Type Material: The holotype male is from Gold Lake, Sierra County, California, July 6, 1928 (C. Hill, ex J. D. Gunder collection), and the allotype female is from the same locality, June 27, 1931 (F. W. Friday, ex J. D. Gunder collection). There are 28 paratypes as follows: 15 male and 7 female (ex J. D. Gunder collection); 5 males and 1 female (L. P. Grey collection), all from Gold Lake, June 23-July 29, all collected by F. W. Friday. The holotype, allotype, and a series of paratypes are in the American Museum of Natural History. The other paratypes are in the collections of the authors."

wrighti, Argynnis W. G. Wright. 10 Oct. 1905. Butt. West Coast United States; p. 139, no. 134. Inadvertently gives a new name for his own Argynnis [laura] laurina. See laurina for data.

4. ARGYNNIS CORONIS BEHR.

bernadensis, Argynnis semiramis Gunder. 2 Sept. 1933. Canadian Ent. 65(8): 172-173. "Holotype - ♀... Camp Wasewgan for Boy Scouts, San Bernardino Mts., San Bernardino Co[unty]., Calif[ornia]., July 14, 1932. Type in Author's coll."

californica, Argynnis Skinner. 3 July 1917. Entomological News 28 (7): 328. ♂ and ♀ described. "Described from fifteen specimens from California, the type and paratypes were taken... at Alma, Santa Clara County." No date data given

coronis, Argynnis Behr. [1-7 Mar. 1865]7. In W. H. Edwards. Proc. Ent. Soc. Philadelphia 3(pp. 327-708): 435, no. 2. No locality, sex, date, nor series data given here. Behr, p. 173, no. 2, Proc. California Acad. Nat. Sci., vol. 2, 1858-1863 says "This

- gerhardi, Argynnis nevadensis meadii Gunder. 31 Dec. 1927. Canadian Ent. 59(12): 287, no. 24; plate B, figs. 24, 24a. "Data: Holotype ♂... Colorado (D. Bruce), no date. In the Strecker Coll., Field Museum, Chicago..."
- harmonia, Speyeria callippe dos Passos and Grey. 14 Sept. 1945. Amer. Mus. Novitates. No. 1297: 6-7; figs. 17-18. "Type Material: The holotype male is from Mount Wheeler (Snake Range near Utah border, Nevada, June 24, 1949 (ex J.D. Gunder collection), and the allotype female is from Mount Wheeler, White Pine County, Nevada, June 30, 1929 (F.W. Morand, ex J.D. Gunder collection). There are 36 paratypes as follows: 30 males and 6 females, same locality as allotype, June 8-July 5, 1929 (F.W. Morand, ex J.D. Gunder collection). The holotype, allotype, and a series of paratypes are in the American Museum of Natural History. The other paratypes are in the collections of the authors."
- inornata, Argynnis W.H. Edwards. Feb. 1872. Trans. American Ent. Soc. 4(1-2) sign. 8: 64 (completed on page 65 in sign. 9). "From a pair belonging to the collection of James Behrens, Esq., of San Francisco, and taken at Downieville, California." No date data given.
- juba, Argynnis Boisduval. [1869, before 1 Nov.] 8. Ann. Soc. Ent. Belgique 12: 60, no. 54. ♂ and ♀ described. "M. Lorquin qui l'a prise en un certain nombre d'exemples dans les prairies élevées de la Juba..." No date data given. Type locality "fixed" (dos Passos and Grey, p. 15, 1947) as Downieville, Sierra County, California.
- laura, Argynnis W.H. Edwards. Mar. 1879. Canadian Ent. 11(3): 49-50. "Nevada" (from article title). "From 4 ♂, 1 ♀ taken by Mr. Morrison, and 1 ♂, 1 ♀ formerly sent me by Mr. Henry Edwards." No date data given. Type locality not "fixed" (dos Passos and Grey, p. 15, 1947) pending further collecting.
- laurina, Argynnis [laura] W.G. Wright. 10 Oct. 1905. Butt. West Coast United States; pp. 138-139, no. 134; plate 15, fig. 134. ♂ and ♀ described. No locality nor series data given. The specimen illustrated by figure 134 was taken "June 20, 1888". "It flies with laura..." (his laura were taken in "S. Cal. Mountains..." Type locality "fixed" (dos Passos and Grey, p. 16, 1947) as Greenhorn Mountains, Kern County, California.
- liliana, Argynnis Henry Edwards. 1877. Proc. California Acad. Sci. 7(1): 170. "I have taken it for three seasons near St. Helena, Napa Co[unty], [California,] and altogether have had before me thirty-four ♂ and seven ♀..." No date data given. Type locality data is supplemented (dos Passos and Grey, p. 14, 1947) to [Bale Station], near [Mount] St. Helena, Napa, Co[unty., California].
- macaria, Argynnis W.H. Edwards. Nov. 1877 - [Dec. 1877] 25. Field and Forest 3(5): 86-87. "From three ♂ one ♀ sent me by Henry Edwards, Esq., and taken at Havilah, California." No date data given.
- meadii, Argynnis W.H. Edwards. Mar. 1872. Trans. American Ent. Soc. 4(1-2) sign. 9: 67-68. "This ... species was first

- species [No. 2, not named] frequents several localities near the Bay of San Francisco. . . " Type locality "fixed" (dos Passos and Grey, p. 11, 1947) as Alma, Santa Clara County, California.
- gunderi, *Argynnis* J. A. Comstock. 15 Nov. 1925. Bull. Sou. California Acad. Sci. 24(3): 67-68. "Types: holotype ♂ Modoc Co [unty]., Calif[ornia]., June 3, 1924. Allotype ♀ Modoc Co., Calif., July 7, 1924. Both coll. author. Paratype. Buck Creek, Modoc Co., July 21, 1922. Coll. Jean Gunder."
- halycone, *Argynnis* W. H. Edwards [May 1869] 26. Butt. N. America 1(3): [81]. plate [28], 2 unnumb. figs. "Female unknown". "From two specimens, taken in Colorado by Dr. Velie, and now in the collection of B. D. Walch, Esq. of Rock Island." No date data given. Type locality "fixed" (dos Passos and Grey, p. 12, 1947) as Estes Park, Larimer County, Colorado.
- hennei, *Argynnis* Gunder. 30 June 1934. Canadian Ent. 66(6): 126-127. "Holotype - ♂ . . . Allotype - ♀ . . . near summit, elevation 7700 ft., Mt. Pinos, Frazier Mountain Park, Santa Barbara Nat. Forest, Ventura Co[unty]., Calif[ornia]., July 10, 1933. Types in Author's coll., including one pair of paratypes (and general series), same place and date. One similar pair of paratypes in Henne coll. Three ♂ paratypes in Comstock coll., Los Angeles Museum, dated June 10 and 13th, 1932, same locality, but lower elevation. One ♂ and one ♀ paratype in collection of W. H. Ireland of Taft, Calif., dated July 3, 1933. A long series of topotypicals is also in the Henne coll. from which he expects to supply examples to Washington and Ottawa."
- semiramis, *Argynnis* W. H. Edwards. 21 Apr. 1886. Canadian Ent. 18(4): 61-62. "From San Bernardino, California, taken by Mr. W. G. Wright. I have upwards of 30 examples of this species, male and female. . ." No date data given.
- simaetha, *Speyeria coronis* dos Passos and Grey. 14 Sept. 1945. Amer. Mus. Novitates. No. 1297: 2-3; figs. 5-6. "Type Material: the holotype male is from Black Canyon, Cascade Mountains, near Brewster, Washington, June 25, 1939, and the allotype is from the same locality, June 20, 1940 (J. C. Hopfinger, L. P. Grey collection). There are 70 paratypes as follows: 2 pair, same locality and collector, June 10-July 20 (L. P. Grey collection); 3 males, same locality and collector (C. F. dos Passos collection). The holotype and allotype are in the American Museum of Natural History. The paratypes are in the collections of the authors."
- snyderi, *Argynnis* Skinner. 4 June 1897. Canadian Ent. 29(6): 154 ♂ described. "I have specimens from Salt Lake City, Utah, taken June 23rd, 1895, and a female from Ogden, July 6th, 1895." Type locality "fixed" (dos Passos and Grey, p. 11, 1947) as City Creek Canyon, Salt Lake City, Salt Lake County, Utah.
5. ARGYNNIS CYBELE (FABRICIUS).
- baal, *Argynnis cybele* Strecker. 1878 [June - before 8 Nov.] 27. Butt. and Moths N. Amer., Compl. Syn. Catal., p. 111, no. 193a, ♂ described. "Ohio." No date given. Type locality data supplemented (dos Passos and Grey, p. 6, 1947) with "[Toledo, Lucas County]".

- carpenterii, Argynnis W.H. Edwards, Apr. 1876, Trans. American Ent. Soc. 5(?) sign. 26: 204-205. "From 2 ♂ 1 ♀, taken in New Mexico, above timber line..." No date data given. Type locality data supplemented (dos Passos and Grey, p. 7, 1947) with "[Taos Peak, Taos County]". Spelled carpenteri by Holland, p. 87, Butt. Book, rev. ed., 1931.
- charlottii, Argynnis Barnes, 1 Feb. 1897, Canadian Ent. 29(2): 39-40. "Types. - 1 ♂ and 2 ♀s in my collection, from Glenwood Springs, Colo[rado]". No date data given. Spelled charlottii by Barnes and McDunnough, Feb. 1917, Check List Lepid. Boreal America, p. 8, no. 157.
- cybele, P[apilio], Nymphalis, Phaleratus. Fabricius, 1775 [17 Apr.]³. Systema Entomologicae; p. 516, no. 311. "Habitat in America, " No sex, date, nor series data given. Type locality "fixed" (dos Passos and Grey, p. 6, 1947) as New York City, New York County, New York.
- daphnis, Papilio, Nymph[alis], Phalerat[us]. Cramer. [1776]³. Uitland, Kapellen Voorkom. Drei Waereld-Deelen Asia, Africa en America 1(8): 152. The butterfly (without a full name - described earlier on page 89) was figured (E-F) on plate 57 in part 5. "Men vindt ze te Nieuw-York en te Jamaika." No date, sex nor series data given. Type locality "fixed" (dos Passos and Grey, p. 6, 1947) as New York City, New York County, New York. A homonym of Papilio daphnis [Denis and Schiffermüller] 1775 [8 Dec.]³.
- daphnis?, Papilio Nymph[alis], Phalerat[us]. Martyn, 1797. Psyche, Figures Nondescript Lepid. Ins., or Rare Moths and Butt. from Differ. Parts of World (?): 7, 7; plate [3], fig. [7]; plate [4], fig. [9]. "This, which is a male from Surinam." No date data given. Type locality "fixed" (dos Passos and Grey, p. 6, 1947) as New York City, New York County, New York. A homonym of Papilio daphnis [Denis and Schiffermüller] 1775 [8 Dec.]³ and Pap. Nymph. Phalerat. daphnis Cramer [1776]³.
- krautwurmi, Argynnis cybele Holland, 6 June 1931, Ann. Carnegie Mus. 20(2) art. 8: 255-256. "Described from four female specimens, type and paratypes, from Les Cheneaux, Upper Peninsula of Michigan. No date data given.
- lethe, Argynnis leto Gunder, 30 June 1934, Canadian Ent. 66(6): 125. "Holotype - ♀... Big Horn Mts., Wyoming... Aug. 3, 1932. Type in Author's coll."
- letis, Argynnis [leto] W.G. Wright, 10 Oct. 1905, Butt. West Coast United States; p. 130, no. 111; pl. 12, fig. 111. "Plate XII, Figure 111, Male; Sisson, Cal[ifornia], August, 1891; Author."
- leto, Argynnis Behr, Dec. 1862, Proc. Calif. Acad. Nat. Sci. 2(sign. 12): 173, no. 3. ♂ and ♀ described. "This species has been discovered... in a sequestered valley near Carson City" [, Nevada]. No date nor series data given.
- letona, Speyeria cybele dos Passos and Grey, 14 Sept. 1945, Amer. Mus. Novitates, No. 1297: 1-2; figs. 3-4. "Type Material: The holotype male and allotype female are from City Creek Canyon, Salt Lake City, Utah, 4500 feet, July 17, 1939 (W.L. Phillips, L.P. Grey collection). There are 41 paratypes as follows: 24

males and 12 females, same locality and collector, July 5- August 24, 1939-1943 (L. P. Grey collection); 4 males Mill Creek, American Fork Canyon, Utah County, August 6, 1932 (ex J. D. Gunder collection). The holotype, allotype, and a series of paratypes are in the American Museum of Natural History. The other paratypes are in the collections of the authors."

novascotiae, Argynnis cybele McDunnough, 2 Feb. 1935. Canadian Ent. 67(1): 18-19. "The types are as follows: Holotype - ♂, White point Beach, Queens Co[unty]., N[ova]. S[cotia]., July 29 (J. McDunnough); No. 3859 in the Canadian National Collection, Ottawa. Allotype - ♀, same locality, July 25. Paratypes - 1 ♂, 9 ♀, same locality, July 18, 24, 25, 28, 29; 10 ♂, S. Milford, N.S., June 30, July 5, 8, 9."

pseudocarpenteri, Argynnis cybele Chermock and Chermock, 30 Apr. 1940. Canadian Ent. 72(4): 82. "Holotype - ♂, July 19, 1934, Sand Ridge, Manitoba [, Canada]. Allotype - ♀, July 7, 1937, Riding Mountains, Manitoba. Paratypes - 1 to 250, Riding Mountains, Manitoba; Sand Ridge, Manitoba; Miniota, Manitoba; Banff, Alberta, and McCreary, Manitoba."

pugetensis, Speyeria cybele Chermock and Fretchin, 30 Oct. 1947. Pan-Pacific Ent. 23(3): 111-112. "Holotype, male, July 12, 1945, Stimson Creek, near Belfair, Mason County, Wash[ington]. Allotype, female, August 4, 1945, Stimson Creek, near Belfair, Mason County, Wash. Paratypes 1-390, various localities in Mason, Kitsap, Thurston and Callam counties, Wash. Paratypes 391-400, Portland and McMinnville, Oregon. The holotype, allotype and paratypes will be deposited in the collection of the American Museum of Natural History. Paratypes will also be distributed to other museums, specialists, and private collections."

valesinoidesalba (emendatio), Acidalia (Semnopsyche) leto Reuss, 10 Apr. 1926. Deutsche Ent. Zeitschrift (Berliner Ent. Zeit. and Deutsche Ent. Zeit. Weider.) Jahrg. 1926(1): 69. ♀ described. No. date, locality nor series data given. "... Typen im Berliner Museum." Originally spelled valesinoides-alba.

6. ARGYNNIS DIANA (CRAMER).

diana, Pap[ilio]. Nymph[alis]. Phaler[atus]. Cramer. [1777]³. Uitland, Kapellen Voorkom, Drei, Waereld-Deelen Asia, Africa en America 2(16): 148. ♂ figured. The butterfly (without full name) was described earlier on page 4 and figured (D-E) on plate 98 in Volume 1, pt. 9. From page 3 (in text of maja): "en Virginie". No date, sex nor series data given. Type locality "fixed" (dos Passos and Grey, p. 6, 1947) as Jamestown, James County, Virginie.

7. ARGYNNIS EDWARDSII REAKIRT

edonis, Argynnis edwardsii Gunder, 30 June 1934. Canadian Ent. 66 (6): 125. "Holotype - ♀... Beaver City, Larimer County, Colorado (10-12, 000 ft.), collected... on Aug. 1, 1892". "Holotype to be placed in the Calif. Academy of Sciences at San Francisco." edwardsii, Argynnis Reakirt, June 1866. Proc. Ent. Soc. Philadelphia 6(pp. 121-152): 137-139. ♂ and ♀ described. "Hab. - California; Pike's Peak, Colorado Territory; Washington, D. C. ? (Coll. W. H. Edwards.) Rocky Mountains. (Coll. Ent. Soc.)"

"Mr. Ridings informs me that he collected this species in August, near Empire City, Colorado Territory, in the heart of the mountains only. It would seem to be rare, since he captured but three specimens (1 ♂, 2 ♀)...". Type locality "fixed" (dos Passos and Grey, p. 10, 1947) as Pike's Peak, Teller County, Colorado. Spelled edwardsi by Holland, p. 99, Butt. Book, rev. ed., 1931.

montana, A[cidalia]. edwardsi Reuss, 25 Jan. 1927. Deutsche Ent. Zeitschrift (Berliner Ent. Zeit. and Deutsche Ent. Zeit. Weider.) Jahrg. 1926(5): 439. "...aus Montana". "Typen, ♂ ♀, und Paratypen im Berliner Museum". No date data given. He also refers to text in the Archiv für Naturgesch. 87A(11): 205, Apr. 1922.

8. ARGYNNIS EGLEIS BEHR.

adiante, Argynnis Boisduval, [1869, before 1 Nov.]⁸. Ann. Soc. Ent. Belgique 12: 61, no. 57. ♂ and ♀ described. "...au bord des bois, dans la partie orientale de la Californie...". No date nor series data given. Type locality "fixed" (dos Passos and Grey, p. 16, 1947) as Santa Cruz, Santa Cruz County, California. Spelled adianthe by Barnes and McDunnough, Check List Lepid. Bor. Amer., p. 8, Feb. 1917.

adiaste, Argynnis W. H. Edwards (Boisduval Ms. name, emended). [1-7 Mar. 1865]⁷. Proc. Ent. Soc. Philadelphia 3(pp. 327-708): 436, no. 7. [California] (from article title). No date, sex nor series data given. Type locality "fixed" (dos Passos and Grey, p. 16, 1947) as Santa Cruz, Santa Cruz County, California. Spelled adraste by Kirby, Syn. Cat. Diur. Lepid., p. 160, 1871.

albrighti, Argynnis Gunder, 31 Dec. 1932. Canadian Ent. 64(12): 281-282. "Holotype - ♂, ... Highwood Mts., Chouteau County, Montana, June 24, 1931. Allotype - ♀, ... same data. Paratype - 1 ♂, Monarch, Cascade County, (just south of the Highwood region), dated July 26, 1931. "Types in Author's coll..."

astarte, Argynnis W. H. Edwards (not Doubleday, not Fisher, not W. H. Edwards, 1862). [1-7 Mar. 1865]⁷. Proc. Ent. Soc. Philadelphia 3(pp. 327-708): 435, no. 4. States that "Egleis, Boisduval in lit." is a synonym of "Argynnis Astarte Doubleday". No series, sex nor date data given. The action of dos Passos and Grey in designating a type and fixing the type locality establish this name as a synonym of Argynnis egleis Behr. The name is a homonym of Argynnis astarte of Doubleday, of Fisher, and of W. H. Edwards, 1862.

atossa, Argynnis W. H. Edwards, 1 Oct. 1890. Butt. N. America 3 (10): [127]-[128]; plate [17]: figs. 4-5. ♂ and ♀ described. Edwards states he saw only the pair figured. Male: "...I was told was North American...". Female: "It was taken at Tehachipe, south California... from July 4 to 8th... in a little valley about four miles from town, by a small stream."

boharti, Argynnis montivaga Gunder, 6 Jan. 1930. Bull. Brooklyn Ent. Soc. 24(5): 326-327; pl. 31, fig. 5. "Data: Holotype ♀... Mono Pass Trail (Yosemite to Mono Lake), Calif[ornia].; July 16, 1929. In author's coll..."

clemencei, Argynnis adiate J. A. Comstock, 15 Nov. 1925. Bull. Sou. California Acad. Sci. 24(3): 67. "Holotype ♂, Atascadero,

- Calif[ornia]., June 30, 1922... Allotype ♀ same data, locality ... Paratype No. 1. Same date, locality..."
- egleis, Argynnis]. Behr (Boisduval Ms. name). Dec. 1862, Proc. California Acad. Nat. Sci. 2(sign. 12): 174, no. 4. "This species is found high up in the mountains". No date, sex nor series data given. Type locality "fixed" (dos Passos and Grey, p. 17, 1947) as vicinity of Gold Lake, Sierra County, California.
- egleis, Argynnis Boisduval. [1869, before 1 Nov.]⁸. Ann. Soc. Ent. Belgique 12: 59-60, no. 53. ♂ and ♀ described. "Cette Argynne est très commune dans les lieux incultes et aux bords des forêts, dans l'intérieur de la Californie". He speaks of having compared more than 100 examples (composed of egleis and irene). No date data given. A homonym of A. egleis Behr, Dec. 1862.
- linda, Argynnis utahensis dos Passos and Grey. 8 Dec. 1942. Amer. Mus. Novitates. No. 1214: 1-2; fig. 1 (left). "Type Material. - Holotype, male, Heyburn Peak, Sawtooth-Boise, Idaho, 9500-10,000 feet, July 15, 1931 (C. W. Herr), Gunder collection, in The American Museum of Natural History. Allotype, female, same data as the holotype and in the same collection. Paratypes: three males, same data; two males, Deadwood, Payette National Forest, Idaho, July 18, 1931 (C. W. Herr); one male, Cape Horn, Challis Payette, Idaho, 7000 feet, July 16-17, 1931 (C. W. Herr); one male, Bear Valley, Challis Payette, Idaho, 7000 feet, July 16-17, 1931 (C. W. Herr); four males, Sawtooth-Lemhi, Idaho, 7500-9500 feet, July 5-17, 1931 (C. W. Herr); and one female, Sawtooth Mountains, Idaho, August 10, 1941 (Dr. and Mrs. R. C. Turner). The male paratypes are from the Gunder collection, and eleven are in the American Museum. Two male and one female paratypes are in the junior author's collection."
- macdunnoughi, Argynnis Gunder. 31 Dec. 1932. Canadian Ent. 64 (12): 280-281. "Holotype - ♂... allotype - ♀... Elkhorn Ranch Resort, Gallatin County, Mont[ana]., Aug. 1, 1928. Types collected by Dr. McDunnough and in the Canadian National Coll. at Ottawa, as well as 2 ♂ paratypes of same date and location. 2 ♂ and 1 ♀ paratypes in Author's Coll., together with a series of males and females taken by Mr. Hutchins, Mr. Wind and Dr. Albright of Great Falls, Montana, in the same region, including the Teton Range south in Wyoming."
- mammothi, Argynnis montivaga Gunder. 8 May 1924. Entomological News 35(5): 157; pl. 2, fig. H. "Data: Holotype ♂, (Coll. of J. Riddell, F. E. S., Hollywood, Calif.) Mammoth Camp, Mono County, California; July 31, 1921. Paratype ♂, (Author's Coll.) Mammoth Camp, Mono County, California; July 28, 1921."
- montivaga, Argynnis Behr. Dec. 1863. Proc. California Acad. Nat. Sci. 3(1) sign. 6: 84, no. 2. "It is not found near the bay [San Francisco Bay], but seems to be widely spread through the Sierra from whence I have specimens collected at different localities. Those obtained by the Geological Survey are from an elevation of 10,500 feet. Type locality "fixed" (dos Passos and Grey, p. 17, 1947) as vicinity of Gold Lake, Sierra County, California. Spelled montivago by Strecker, pages 113 and 114, Butt. and moths N. Amer., Compl. Syn. Catal., 1878. Spelled montivaga by dos Passos and Grey, 1945, Amer. Mus. Nov. (1297): 7.

oweni, Argynnis W.H. Edwards, 28 Apr. 1892. Canadian Ent. 24 (5): 105-106, no. [1] (not 2 as given). "From 87 males and 6 females taken by Professor Edward T. Owen on Mt. Shasta, elevation 7,500 feet [, California]. No date data given.

secreta, Speyeria montiviga dos Passos and Grey, 14 Sept. 1945. Amer. Mus. Novitates, No. 1297: 7-8; figs. 19-20. "Type Material: The holotype male and the allotype female are from Rocky Mountains National Park, Colorado, 8000 feet, July, 1942, collected by Roy Weist (L. P. Grey collection) in the Estes Park area. There are 4 paratypes as follows: 3 male and 1 female with the same data. The holotype and allotype are in the American Museum of Natural History. The paratypes are in the collections of the authors."

tehachapina, Argynnis J. A. Comstock, 5 May 1920. Southwest Science Bulletin; pp. 6-9; plate [1], figs. 7-9. "Described from three males and one female, taken on highest peak in Tehachapi Mts., [California,] July 18, 1918. In the collection of the author, Southwest Museum, Los Angeles."

tejonica, Argynnis atossa J. A. Comstock, 15 Nov. 1925. Bull. Sou. California Acad. Sci. 24(3): 68. "Type. Our example is a ♀ and was taken by Mr. Jean Gunder in the Tejon region (Collins Ranch) [California] on August 12, 1923."

utahensis, Argynnis Skinner, 10 Oct. 1919. Entomological News 30 (8): 216. ♂ and ♀ described. "The type was taken by the writer in City Creek Canyon, Salt Lake City, Utah, July 6th, and the allotype at Silver Lake, Brightons, Utah, July 12th. There are nine paratypes from City Creek Canyon, taken on the 4th to the 6th July. Fourteen specimens from Ogden, Utah, and four from Park City, Utah, taken by A. J. Snyder in the first half of July. Three specimens from Provo, Utah, taken by T. Spalding in July, and four specimens from David Bruce labelled "Utah."

9. ARGYNNIS HYDASPE BOISDUVAL.

caliginosa, Argynnis hydaspe J. A. Comstock, 15 Nov. 1925. Bull. Sou. California Acad. Sci. 24(3): 66. "Type. ♂ Modoc Co[unty]. Calif[ornia]. No date. Collection. Mr. J. E. Cottle."

conquista, Speyeria hydaspe dos Passos and Grey, 14 Sept. 1945. Amer. Mus. Novitates, No. 1297: 8; figs. 21-22. "Type Material: The holotype male is from little Tesuque Canyon, near Sante Fe, New Mexico, 8000 feet, August 8, 1932 (A. B. Klots), and the allotype female is from Therma, New Mexico, August 12, 1932 (A. B. Klots). There is one paratype, a female, same locality as holotype, July 8, 1932 (A. B. Klots, C. F. dos Passos collection). The holotype and allotype are in the American Museum of Natural History. The paratype is in the collection of the senior author."

gregsoni, Argynnis rhodope Gunder, 31 Dec. 1932. Canadian Ent. 64(12): 281. "Holotype - ♀... Mt. Washington (6000 ft.). Forbidden Plateau, V[ancouver, I[sland]., B[ritish]. C[olumbia]., Can[ada]. July 7, 1931. Type in Author's coll."

hydaspe, Argynnis Boisduval, [1869, before 1 Nov.]⁸. Ann. Soc. Ent. Belgique 12: 60, no. 55. ♂ and ♀ described. "Du sud de la Californie où elle vole avec l'espèce suivante (= cybele = [leto])." No date nor series data given. Type locality "fixed" (dos Passos

and Grey, p. 21, 1947) as Yosemite Valley, Mariposa County, California.

minor, Argynnis hydaspe rhodope McDunnough. 25 July 1927. Canadian Ent. 59(7): 154-155. "Holotype - ♂, Mt. McLean, B[ritish]. C[olumbia].; June 12, 1926, (J. McDunnough). Allotype - ♀, same data. Paratypes - 2 ♂, 1 ♀, same data; 1 ♂ Lilloet, B. C., 4600 ft., July 14, 1916; 1 ♂ McGillivray Creek, Anderson Lake, B. C., Aug. 9, 1916; No. 2427 in the Canadian National Collection, Ottawa."

purpurascens, Argynnis monticola Henry Edwards. 1877. Proc. California Acad. Sci. 7(1): 170-171. "This beautiful variety was first taken by Mr. W. G. W. Harford, at the Dalles, Oregon, and subsequently by Mr. J. Behrens at Soda Springs, Siskiyou County, [California,] in which last locality I took about forty specimens... in the fall of 1875." No sex data given. Type locality given (dos Passos and Grey, p. 21, 1947) as Soda Springs, Siskiyou County, [California].

rhodope, Argynnis W. H. Edwards. Jan. 1874. Trans. American Ent. Soc. 5(?) sig. 2: 13-14. "From 3 ♂, 1 ♀, taken in British Columbia, in 1873, by G. R. Crotch, Esq." No date data given. Type locality "fixed" (dos Passos and Grey, p. 21, 1947) as Cariboo District, British Columbia.

sakuntala, Argynnis Skinner. 28 Feb. 1911. Entomological News 22 (3): 108. "Described from four males and one female. Habitat. - Ainsworth, B[ritish]. C[olumbia]., Aug. 13, 1903, Rev. G. H. Findley; Kalso, B. C., July 7, 1890, J. W. Cockle; Laggan, Alberta, T. E. Bean. Type Locality - Kalso, B. C. The specimens, excepting those from Laggan, were kindly submitted for study by Dr. C. Gordon Hewitt, Dominion Entomologist. The Alberta specimens and the type are in the collection of the Academy of Natural Science, of Philadelphia."

skinneri, Argynnis Holland. 1931 [before 31 Oct.]²⁸. Butt. Book, rev. ed.; p. 95; plate 56, fig. 4. Proposes new name for Argynnis sakuntala Skinner which he considered too close to the name Argynnis sakontala Kollar, 1848. See sakuntala Skinner for data.

viridicornis, Argynnis hydaspe J. A. Comstock. 15 Nov. 1925. Bull. Sou. California Acad. Sci. 24(3): 63-64. "Types. Holotype ♂ Greenhorn Mountains, Calif[ornia]., July, 1923, W. H. Ireland. Allot type ♀, same locality, date, and collector. 3 paratypes, all taken at the same place, on the same date, by Mr. Ireland. Two of these will be deposited in the Barnes collection. The remainder are in the collection of the Southwest Museum."

10. ARGYNNIS IDALIA (DRURY).

ashtaroth, Argynnis Fisher. Dec. 1859 - [before 30 Mar. 1860]⁶. Proc. Acad. Nat. Sci. Philadelphia [11] (sign. 27): 352. A new name for his own Argynnis astarte, a preoccupied name. See his astarte for data.

astarte, Argynnis Fisher. Oct. 1858 - [before 31 Mar. 1859]⁶. Proc. Acad. Nat. Sci. Philadelphia [10] (13): 179-180; plate 2, 2 unnumb. figs. "... found... in New Jersey... in July... on Succasunna Plains, near Schooley's Mountain, in Morris Co[unty]. " No sex given. A homonym of Argynnis astarte Doubleday in Doubleday and Hewitson, Genera Diur. Lepid.; v. 1; plate 23, fig. 5; [4 Oct. 1847]¹.

dolli, Argynnis idalia Gunder. 31 Dec. 1927. Canadian Ent. 59(12): 286, no. 20; plate B, figs. 20, 20b. "Data: Holotype ♀... Richmond Hill, Long Island, N[ew]. Y[ork]... July 15, 1886. In Coll. Brooklyn Museum, Brooklyn, N. Y."

idalia, Nym[phalis]. Phal[eratus]. Drury. [1773]³. Illust. Nat. Hist. I: [1] in Index. Described on page 25 and illustrated (figs. 1-3) on plate 13 but without any name. "I received them from New York, where they were taken on the 28th of June." No series data given. Type locality "fixed" (dos Passos and Grey, p. 9, 1937) as New York City, New York County, New York.

infumata, Argynnis idalia Oberthür. July 1912. Études Lépid. Comparée 6: 315; pl. 104, fig. 969. 1 ♂ described. "Newark, N [ew]. J[ersey]., juillet 1909."

pallida, Argynnis idalia Eisner. 1942. Zool. Mededeel. uitgegeven door het Rijksmuseum van Natuurlijke Hist. te Leiden 24(1-2): 124. "Patria: Decorah (Iowa); Oak Park (Ill [inois].). "Typus 1 ♂, Decorah, Iowa, 18. VII. 1912, ex Dr. A. Collier, im Rijksmuseum van Natuurlijke Histoire, Leiden. Paratypus 1 ♂, ebenda."

11. ARGYNNIS MORMONIA BOISDUVAL.

arge, Argynnis Strecker. 1878 [June - before 8 Nov.]²⁷. Butt. and Moths N. Amer., Compl. Syn. Catal., p. 114, no. 210. California". No date, sex nor series data given. Type locality "fixed" (dos Passos and Grey, p. 23, 1947) as Monache Meadows, Tulare County, California.

artonis, Argynnis W. H. Edwards. [11 Mar. 1881]²³. Trans. American Ent. Soc. 9(1) sign. 1: 1-2. ♂ and ♀ described. "... it flies in Colorado, but is rare. Mr. Mead met with three or four examples in 1872... I have received a single male from Big Horn, Montana; and recently have seen two females from Wells, Elko, Co[unty]., Nevada. These formed part of the collection of Mr. J. Elywyn Bates of South Albington, Massachusetts..." Type locality "fixed" (dos Passos and Grey, p. 23, 1947) as Wells, Elko County, Nevada.

astarte, Argynnis W. H. Edwards (not Doubleday, not Fisher). [5-12 Aug. 1862]⁷. Proc. Ent. Soc. Philadelphia 1(7): 221-222. ♂ and ♀ described. No series nor date data given. "Oregon; California". Misidentifies astarte of Doubleday. The action of dos Passos and Grey in designating a type and fixing the type locality establishes this name as a synonym of Argynnis arge Strecker, 1878. The name is a homonym of Argynnis astarte of both Doubleday and Fisher.

benjamini, Argynnis mormonia Gunder. 31 Dec. 1927. Canadian Ent. 59(12): 287, no. 22; plate B, figs. 22, 22a. "Data: Holotype ♂, ... Arangie, Idaho, no date. In Barnes Coll."

bischoffii, Argynnis W. H. Edwards. Nov. 1870. Trans. American Ent. Soc. 3(?) sign. 25: 189-190. "From 1 ♂, 1 ♀... Taken in Alaska, opposite Kodiak..." No date data given. Spelled bischoffi, by Holland, p. 102, Butt. Book, rev. ed., 1931.

brucei, Argynnis eurynome Gunder. 31 Dec. 1927. Canadian Ent. 59(12): 287, no. 23; plate B, figs. 23, 23a. "Data: Holotype ♀... Colorado... 1890. In Strecker Coll., Field Museum, Chicago..."

- clio, Argynnis W.H. Edwards, Oct. 1874, Trans. American Ent. Soc. 5(?) sign. 14: 106-107. "The first examples $\sigma\sigma$ seen by me... were taken on the plains at the Teton Mountains... a φ was sent me... taken... in the Rocky Mountains." No date data given. Type locality "fixed" (dos Passos and Grey, p. 23, 1947) as Jackson, Teton County, Wyoming.
- cunninghami, Argynnis erinna Owen, Sept. 1893, Entomological News 4(7): 246. "Hab. - Klammath County, Oregon." No sex nor date data given. One specimen is indicated.
- erinna, Argynnis eurynome W.H. Edwards, 18 Mar. 1883, Canadian Ent. 15(2): 33-34. "I have 12 σ , 4 φ from Spokane Falls, W [ashington]. T[erritory]... and 1 σ taken in Colorado... in 1871. Also I have a female nearer the Colorado type of eurynome... at Mt. Hood, Oregon". "Two females from Big Horn, Mont[ana]... , agree with this, but are large as the usual Colorado form." Type locality "fixed" (dos Passos and Grey, p. 23, 1947) as Spokane Falls, Spokane County, Washington. Spelled errinna by Wright, 1905, Butt. W. Coast U.S., p. 53, under no. 144.
- eris, Arg[y]nnis. eurynome Igel, 3 June 1922, Ent. Zeitschrift, Zentral-Organ des Internat. Vereins Frankfurt am Main 36(5): 20. "Jedesmal stammten die Tiere aus der Umgebung von Calgary (Alberta). Die Type in meiner Sammlung fällt auch gegen meine übrigen Stücke aus Montana eine etwas geringere Größe auf." No date nor sex data. A homonym of Argynnis eris Meigen [1828]²¹, Syst. Beschreib. Europ. Schmett. 1(?): 64-65, no. 19.
- eurynome, Argynnis W.H. Edwards, Mar. 1872, Trans. American Ent. Soc. 4(1-2) sig. 9: 66-67. σ and φ described. "Mr. Mead found the species common throughout Colorado..." No date nor series data given. Type locality "fixed" (dos Passos and Grey, p. 23, 1947) as Fair Play, Park County, Colorado. Spelled eury-nomes by Edwards, 1874, in Hayden's Rept. for 1873, p. 542.
- fieldi, Speyeria mormonia eurynome dos Passos and Grey, 12 Dec. 1947, Amer. Mus. Novitates, No. 1370: 23-24. Propose new name for Argynnis eurynome clio gunderi Field, June 1936 which is a homonym of Argynnis gunderi J. A. Comstock, 15 Nov. 1925. See gunderi Field for specimen data.
- gunderi, Argynnis eurynome clio Field, June 1936, Jour. Ent. and Zool. (Pomona College) 28(2): 23. "Data: Holotype male... Broadwater Co[unty]., Montana, July 27, 1930". "Type in the author's collection." A homonym of Argynnis gunderi J. A. Comstock, 15 Nov. 1925.
- igeli, Speyeria mormonia eurynome dos Passos and Grey, 12 Dec. 1947, Amer. Mus. Novitates, No. 1370: 23-24. Propose new name for Arg. eurynome eris Igel, 3 June 1922 which is a homonym of Argynnis eris Meigen [1828]²¹. See eris Igel for details.
- jesmondensis, Argynnis bischoffi opis McDunnough, 11 Mar. 1940, Canadian Ent. 72(2): 25. "Holotype - σ , Jesmond, B[ritish]. C[olumbia]., July 24, 1937, (3500 ft.) (J.K. Jacob); No. 4925 in the Canadian National Collection, Ottawa. Allotype - φ , same data, Aug. 3, 1937. Paratypes - 23 σ , 11 φ , same locality and collector; various dates in 1937 and 1938 from July 14 - Aug. 3."

- luski, Argynnis eurynome Barnes and McDunnough. 15 Apr. 1913. Contrib. Nat. Hist. Lepid. N. America 2(3): 95-96, and 146; plate 1, figs. 1-4. "Habitat. White Mts., Arizona (Lusk). 7 ♂, 7 ♀. Types, Coll. Barnes." No date data given.
- montivaga, Argynnis Behr. (not Behr, 1863). [1 - 7 Mar. 1865]7. In W. H. Edwards. Proc. Ent. Soc. Philadelphia 3(pp. 327-708): 435, nos. 4 and 5. "...always found in mountainous regions..." of California (from article title). No sex, series nor date data given. The action of dos Passos and Grey in designating a type and fixing the type locality establish this name as a synonym of Argynnis arge Strecker, 1878 and as a homonym of Argynnis montivaga Behr, 1863. Spelled montivago by Strecker, pages 113 and 114, Butt. and Moths N. Amer., Compl. Syn. Catal., 1878.
- mormonia, Argynnis Boisduval, [1869, before 1 Nov.]8. Ann. Soc. Ent. Belgique 12: 58-59, no. 51. ♂ and ♀ described. "M. Lor-l'a trouvée assez abondamment en été sur les frontières de l'Oregon." Type locality "fixed" (dos Passos and Grey, p. 22, 1947) as Salt Lake City, Salt Lake County, Utah.
- opis, Argynnis W. H. Edwards, Oct. 1874. Trans. American Ent. Soc. 5(?) sign. 14: 105-106. ♂ and ♀ described. "From several specimens taken at Bald Mountain, Cariboo, British Columbia, by the late G. R. Crotch, in 1873."
- rainierensis (corrected), Argynnis eurynome washingtonia Gunder. 31 Dec. 1932. Canadian Ent. 64(12): 282. "Holotype - ♂... Paradise Valley, Mount Ra[i]nier, Pierce Co[unty]., Washington, Aug. 12, 1931. Allotype - ♀... same locality, Aug. 10, 1931. Paratypes - 3 ♂ and 3 ♀, Aug. 8 to 12, 1931, same place. One pair deposited in U. S. National Museum (Barnes Coll.), Washington, D. C., and one pair placed in Canadian National Coll. at Ottawa, Ont., Can. Types in Author's coll. Originally spelled ranierensis.
- rubyensis, Argynnis eurynome artonis Gunder. 31 Dec. 1932. Canadian Ent. 64(12): 282-283. "Holotype - ♂... Franklin Slough, near Wright's Ranch, Ruby Valley, Elko Co[unty]., Nevada., July 9, 1929. Allotype - ♀... same place, July 12, 1929. Paratypes - 6 ♂, same locality and dates. 1 ♂ deposited in U. S. National Coll. (Barnes Coll.), Washington, D. C., and 1 ♂ deposited in Canadian National Coll., Ottawa, Can. Types in Author's coll."
- washingtonia, Argynnis bischoffi Barnes and McDunnough. 15 Apr. 1913. Contrib. Nat. Hist. Lepid. N. America 2(3): 95 and 146; plate 1, figs. 5-8. "Habitat. Mt. Ra[i]nier, Wash[ington]. (7000 ft.) (July 24-30) (McDunnough). 7 ♂, 7 ♀. Types, Coll. Barnes."
12. ARGYNNIS NOKOMIS W. H. EDWARDS.
apacheana, Argynnis Skinner. 2 Feb. 1918. Entomological News 29(2): 67-68. Applies this new name to the four figures on the redrawn plate of nokomis (Argynnis IV) given by W. H. Edwards in his Butt. N. America, [Ser. 1]. "Mr. Edwards, having received five males and two females, of what I call apacheana, brought from Arizona..." No dates given by Edwards.
- coerulescens, Argynnis nitocris Holland. Jan. 1900. Entomological News 11(1): 332-333. ♂ and ♀ described. "I... received a col-

lection of Lepidoptera made... in the state of Chihuahua, Mexico. The collection was taken at the head of the Rio Piedras Verdes, in Chihuahua, at an elevation of from 7,100 to 7,300 feet above sea level in the Sierra Madre region". "This form appears to be not uncommon in the month of September in the locality from which the specimens came. No series data given. Spelled caerulescens by McDunnough, 1938, Mem. Sou. Calif. Acad. Sci. 1: 14, no. 164a.

hermosa, Argynnis apacheana J. A. Comstock, 20 May 1925, Bull. Sou. California Acad. Sci. 24(1): 3-4. "Type: One male, Round Valley, Inyo County, California, July 30, 1922. In the collection of the author, Southwest Museum, Los Angeles."

nigrocaerulea, Argynnis nitocris Cockerell and Cockerell, Dec. 1900, Entomological News 11(10): 622. ♂ and ♀ described. "Hab. - Beulah, Sapello Canon, New Mexico, middle of August, 1900". "Specimens are in Dr. Skinner's collection". No series data given.

nitocris, Argynnis W. H. Edwards, Jan. 1874, Trans. American Ent. Soc. 5(?) sign. 2: 15-16. "From one male taken at White Mountains, Arizona, by Lieut. Henshaw of the exploring Expedition under Lieutenant Wheeler, August, 1873."

nokomis, Argynnis W. H. Edwards, [1862, Apr. - 1 Aug.]⁶. Proc. Acad. Nat. Sci. Philadelphia [14] (5): 221-222, "Rocky Mountains of California". "The female I have not seen". No date nor series data given. Type locality "fixed" (dos Passos and Grey, p. 9, 1947) as Mount Sneffels, Ouray County, Colorado.

nokomis, Argynnis W. H. Edwards (not W. H. Edwards, 1862). [Jan. 1873]²⁶. Butt. North America 1(Suppl.): [71-72] (revised text); pl. [23], figs. 1-4 (redrawn). "5 ♂, 2 ♀, brought from Arizona by the Exploring Expedition under Lieut. Wheeler, in 1871, but no further intimation of their locality." No date data given. This represents a different insect than what Edwards originally called nokomis and was subsequently named apacheana by Skinner.

rufescens, Argynnis nitocris nigraerulea Cockerell, 15 July 1909. The Entomologist's Rec. and Jour. Variation 21(7-8): 186. "At Beulah, in the Sapello Cañon, [New Mexico,] my wife found a magnificent female (ab. rufescens, nov.)." No date data given.

valesinoidesalba (emendatio), Acidalia (Semnopsyche) nokomis Reuss. 10 Apr. 1926. Deutsche Ent. Zeitschrift (Berliner Ent. Zeit. and Deutsche Ent. Zeit. Weider.) Jahrg. 1926(1): 69. ♀ described. No date, locality nor series data given. "... Typen im Berliner Museum." Originally spelled valesinoides-alba.

wenona, Speyeria dos Passos and Grey. 14 Sept. 1945, Amer. Mus. Novitates. No. 1297: 1; figs. 1-2. "Type Material: The holotype male and allotype female were taken, in copula, in a sub-alpine meadow, 12,000 feet, Cerro Potosi, Municipio de Galeana, Nuevo Leon, Mexico, July 18, 1938, by R. A. Schneider. They are in the American Museum of Natural History."

13. ARGYNNIS ZERENE BOISDUVAL.

behrensi, Argynnis W. H. Edwards, Sept. 1869, Trans. American Ent. Soc. 5(?) sign. 48: 370-371. "Taken at Mendocino, California. From 1 ♂, 1 ♀, in the Collection of James Behrens"... No date data given. Spelled behrensi by Holland, p. 93, Butt. Book, rev. ed., 1931.

bremnerii, *Argynnis* W. H. Edwards. Feb. 1872. Trans. American Ent. Soc. 4(1-2) sign. 8: 63-64. "From 2 ♂, 1 ♀, taken on San Juan Island... in 1871... and in the collection of Henry Edwards..." Spelled bremneri by Holland, p. 93, Butt. Book, rev. ed., 1931.

carolae, *Argynnis coronis* dos Passos and Grey. 8 Dec. 1942. Amer. Mus. Novitates No. 1214: 2-4; fig. 1 (left). "Type Material. - Holotype, male, Charleston Park, Clark County, Nevada July 8-9, 1928 (Eugene Schiffel), Gunder collection, in The American Museum of Natural History. Allotype, female, same data as holotype and in the same collection. Paratypes, twenty-four males and eight females: six, Charleston Park, Clark County, Nevada, 8000 feet, July 8-9, 1928; nine, Charleston Range, Clark County, Nevada, 10,000-11,000 feet, July 10-15, 1928; four, Charleston Range, Clark County, Nevada, 6000-8000 feet, July 15-28, 1928; eleven, Charleston Park, Lincoln County, Nevada, 8000 feet, July 9-24, 1928; and two, Charleston Park, Lincoln County, Nevada, 10,000 feet, July 13-15, 1928. Since the Charleston Mountains are almost entirely in Clark County, the last thirteen paratypes recorded are undoubtedly wrongly labeled "Lincoln Co." All are from the Gunder collection and, except for three male and two female paratypes in the junior author's collection, all are in The American Museum of Natural History."

conchyliatus, *Argynnis zerene* J. A. Comstock. 15 Nov. 1925. Bull. Sou. California Acad. Sci. 24(3): 63. "Types. ♂ holotype, Mt. Shasta, Calif[ornia]., July 19, 1921. ♀ allotype, Northern California, no date, collected by Cottle. Paratypes Nos. 1 to 4, ♂♂ Shasta Co[unty]., Calif., June 4th to July 10th. Nos. 5 to 8, Shasta Retreat, Siskiyou Co., Calif., June 16 to July 15. Coll. Barnes. Paratypes Nos. 9 to 12, ♀♀ Shasta and Humboldt Counties, Calif., July 5 to August 11, 1923. Nos. 13 to 16, Shasta Retreat, Siskiyou Co., Calif., July 1 to August 23. Coll. Barnes."

cynna, *Speyeria zerene* dos Passos and Grey. 14 Sept. 1945. Amer. Mus. Novitates, No. 1297: 4-5; figs. 11-12. "Type Material: This insect is described from a type series of 25 males and 9 females, all from Ruby Valley, Elko County, Nevada, as follows: holotype male, Humboldt National Forest, 1931-1932 (E. Schiffel, ex J. D. Gunder collection), and allotype female, Wright's Ranch, July 12-24, 1931 (ex J. D. Gunder collection). There are 32 paratypes as follows: 10 males and 6 female, July 12-26 (ex J. D. Gunder collection); 3 males and 1 female, July 12-24 (C. F. dos Passos collection); 12 males, various collectors and dates, July 12-July 16 (L. P. Grey collection). The holotype, allotype, and a series of paratypes are in the American Museum of Natural History. The other paratypes are in the collection of the authors."

garretti, *Argynnis* Gunder. 31 Dec. 1932. Canadian Ent. 64(12): 282. "Holotype - ♂... Cranbrook, B[ritish]. C[olumbia]., Can[ada]., July 29, 1929. Allotype - ♀... same locality, July 27, 1929. Paratypes - 2 ♂ and 2 ♀; one pair deposited in Canadian National Coll.,

- at Ottawa, Can., and one pair placed in the U. S. National Museum (Barnes Coll.), Washington, D. C. A series of topotypical examples in both sexes in Author's coll., including the types."
- gloriosa, Speyeria zerene Moech, 1957. Geographic variability in Speyeria. Comments, records and description of a new subspecies. Paper presented to and sponsored by the Milkawkee Entomological Society; pp. 21-24; 19 figures and 1 map. "The type series was taken in the Illinois River Valley, Josephine County, southwestern Oregon, on the road leading west from Selma, along the river, from about 1,600 feet elevation down to about 1,100 feet. The catch was made on July 22, 1956. In addition to the holotype and allotype, both to be deposited in the American Museum of Natural History, New York, only seven females and eleven males are in sufficiently good condition to make paratypes. Aside from a pair to Grey, I shall try to keep the remaining paratypes together. The variation in this genus can be studied only in series; it would be a meaningless gesture to deposit individual examples here and there in separate museums. The present description makes known the fact of the occurrence of bremnerii-zerene intergradation in the southern Oregon Coast Range..."
- hippolyta, Argynnis W. H. Edwards, May 1879. Canadian Ent. 11(5): 81-82. "From 3 ♂ 1 ♀ received from Mr. G. M. Dodge, and taken in Oregon, but in what exact locality is not known. Another male was received from Mr. Edwards, from Northern California." No date data given. Type locality "fixed" (dos Passos and Grey, pp. 12-13, 1947) as Oceanside, Tillamook County, Oregon.
- malcombi, Argynnis J. A. Comstock, 5 May 1920. Southwest Science Bulletin; pp. 4-5; plate [1], figs. 5-6. "Described from 10 males and 4 females taken by Mr. Geo. Malcomb, as follows: 8 at Mammoth, California], Aug. 1 st to 18th, 1918 (The Type, Aug. 18th). 1 at Dead Man's Creek, Mono Co[unty], July 27, 1919. 4 at Casa Diablo Lake, Mono Co., July 22, 1919. 1 at Silver Lake, Mono Co., July 22, 1919. Type, in author's collection, Southwest Museum. Cotypes in the George Malcomb Collection, Los Angeles."
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- myrtilae, Speyeria zerene dos Passos and Grey. 14 Sept. 1945. Amer. Mus. Novitates. No. 1297: 3-4; figs. 7-8. "Type Material: The holotype male is from San Mateo, California, July 27, 1919, and the allotype female is from the same locality, August 10, 1919. There are 5 paratypes as follows: 1 male and 4 females from the same locality, August 10-24. All... are in the American Museum of Natural History."
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- sordida, Argynnis [bremneri] W. G. Wright. 10 Oct. 1905. Butt. West Coast United States; p. 133, under no. 119. "I have taken in that locality" [Puget Sound, Wash[ington]., ? August, 1891]. No sex nor series data given.
- zerene, Argynnis Boisduval. 1852 [Aug.]²⁴. Ann. Soc. Ent. France. 2nd. ser. 10(2): 303, no. 44. ♂ and ♀ described. "Cette jolie espèce, au moins aussi intéressante que la précédente, se trouve en juin au bord des bois, dans les montagnes peu élevées." No series data given. Type locality "fixed" (dos Passos and Grey, p. 12, 1947) as Yosemite Valley, Mariposa County, California.

FOOTNOTES

1. Hemming, 1936-1943, Jour. Soc. Bibliog. Nat. Hist. 1: 335-464. Gives publication dates for the Genera Diur. Lepid.
2. No. 847: Dec. 1933 was received at the Boston Soc. Nat. Hist. Library (now Allen Hancock Foundation Library, Univ. Scu. Calif.) on Dec. 19 1933.
3. Hemming, 1958, Official List Works Approv. Avail. Zool. Nomencl. 1st. Install.: pp. 7-10. Gives established dates for certain works of Cramer, Denis and Schiffermüller, Drury and Fabricius.
4. Maynard's work has no title page date; the introduction (p. iv) is dated Feb. 1886.
5. Sherborn, 1922, Index Animalium, 2nd. Ser. Vol. A-B: cxxxi. Gives publication dates for Zetterstedt's work.
6. Index Scient. Cont. Jour. and Proc. Acad. Nat. Sci. Phila. 1812-1912: pp. xii-xiii. Gives dates of receipt for certain early numbers of the Proceedings.
7. Brown, 31 Jan. 1964, Trans. Amer. Ent. Soc. 89: 305-308. Gives dates for Proc. Ent. Soc. Phila. vols. 1-6.
8. Trans. Ent. Soc. London. 1869: p. xix (in Proc.). Notes receipt of Tomes 1-2 of the Ann. Soc. Ent. Belg. at Nov. 1, 1869 meeting. Boisduval's separate of the article may have been issued earlier.
9. Hemming, 1937, Hübner 1: 146-324. Gives dates for Samm. Europ. Schmett.
10. Sherborn and Woodward, 1901, Ann. and Mag. Nat. Hist. Ser. 7. 7: 137-140. Gives dates for Esper's work.
11. Hemming, 1937, Hübner 1: 327-437. Gives dates for Samm. Exot. Schmett.
12. Griffin, 1936, Trans. R. Ent. Soc. London 85: 243-279. Gives receipt dates for Seitz's work.
13. Pt. 3 title page signature date of 1878 is qualified as a transmittal letter date of 8 Aug. 1878 (p. 1847). The report is mentioned as available in Bull. Brklyn. Ent. Soc. 2 (3: July 1879): p. 28.
14. Scudder, 1899, Psyche, Jour. Ent. 8: 153-154. Gives dates for several of Boisduval's works.
15. Dos Passos, "1958" [1959], Lepid. News 12 (3-4): 119-120. Gives dates for Vol. 9 of the Encycl. Meth.
16. Title page is dated 1832. Cat. Libr. Mus. Brit. Vol. 2: p. 686 (in Godart) says pp. 1-128 were issued in 1832.
17. Title page of Tome 1 also dated 1787 and its preface (p. vi) is dated 3 Feb. 1787.
18. Clark, 1951, Smithsonian Misc. Coll. 116(7): 188. Gives date of Bull. 157 as 13 Feb. 1932.
19. The date on No. 26 is qualified by the first date of availability that I can find (see Bull. Brklyn Ent. Soc. Vol. 1 [no. Nov. 1878]: p. 59).
20. No. 6 dated Dec. 1877 is noted in Psyche, vol. 2, p. 156 as being received in Feb. 1878.
21. Dos Passos and Grey, 1947, Amer. Mus. Nov. (1237): p. 23. Give date as 1828.

22. I received vol 63 on 12 Mar. 1957, the printed date of issue (in next volume) is probably earlier than this but I have not seen it.
23. Signs, 1-2 (pp. 1-16) available at meeting of 11 Mar. 1881 (see Trans. Amer. Ent. Soc. 9: p. ii).
24. Dos Passos, 1962. Jour. Lepid. Soc. 16 (1): 45-46. Gives date for Boisduval's 1852 article.
25. No. 5 dated Nov. 1877 is noted in Psyche, vol. 2, p. 156 as being received in Dec. 1877.
26. Hemming, 1931. Proc. Ent. Soc. London, Ser. A. 6: 42-45. Gives actual publication dates for the parts of Edward's Butt. N. Amer. , ser. 1.
27. Work title page date is qualified by date on page 251 and a notice of receipt given in Psyche, vol. 2 (nos. 49-52): 166, no. 996. Nos. 49-52 were issued 8 Nov. 1878.
28. Work title page date of 1931 is qualified by a review in Can. Ent. 63 (10) : 244-246, No. 10 was issued 31 Oct. 1931.

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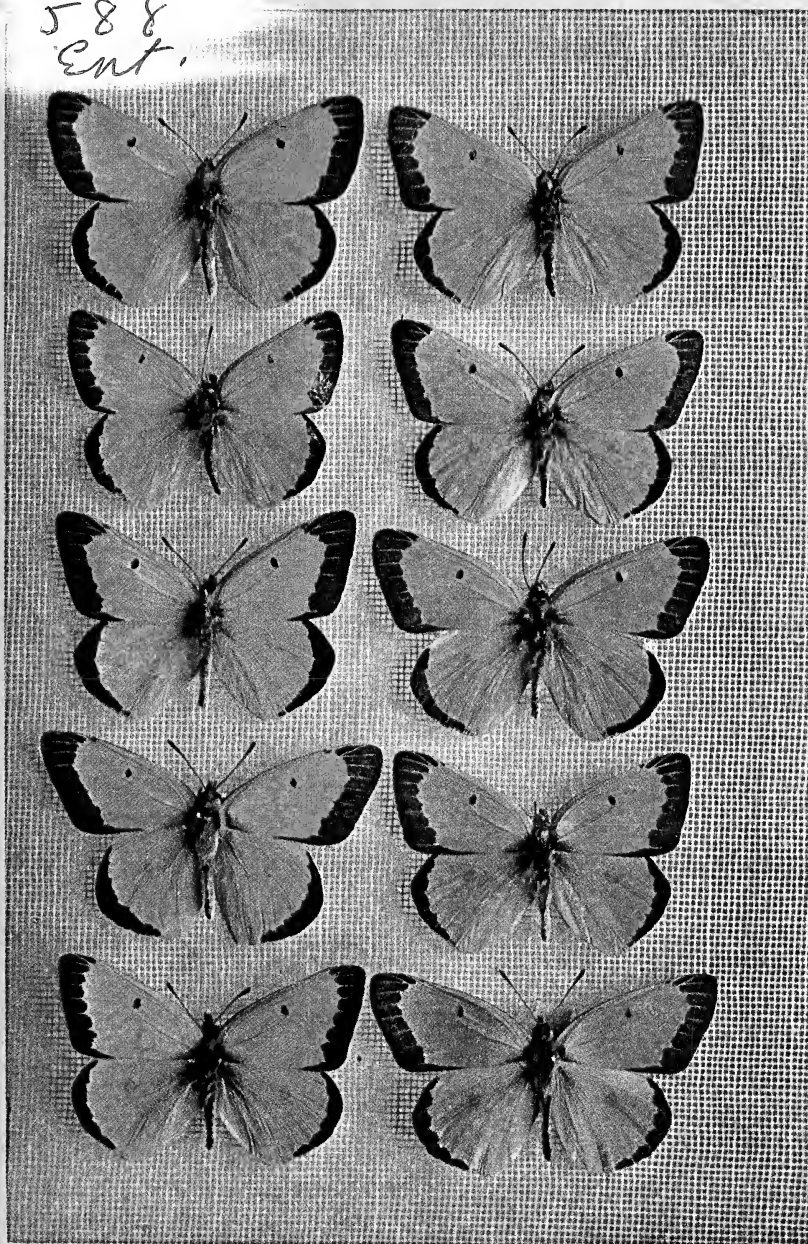
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POLYMORPHISM IN *SUNIRA BICOLORAGO* (NOCTUIDAE)

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Sunira bicolorago IS NORMALLY the commonest autumn Noctuid in the northeastern United States. In peak years it fairly swarms at light, even in metropolitan areas. In the course of handling large numbers of this species attracted to light in Pennsylvania in the autumn of 1961, the author's attention was called to its variability. Breeding experiments were initiated which, combined with continued sampling, have provided some preliminary information on the nature of the polymorphism observed.

The normal form at Philadelphia is nymotypical *bicolorago*, characterized by a rather uniform orange-buff coloration, varying to straw and orange ochre, but without marked contrasts. The hind wing may be unmarked straw or more or less heavily infuscated with gray, often with a poorly-defined postmedial line and a dark but vague terminal shade, sometimes with traces of a discal dot. The medial shade of the fore wing ranges from hardly distinguishable to strongly contrasting, as do the dark shades on either side of, and defining, the subterminal line. All of the markings on the fore wing vary greatly in strength. The lightest *bicolorago* of both sexes, with straw hind wing and light buff fore wing with no strong markings, have been called *decepiens* Grt. In long series it may be seen that they intergrade completely, and the usefulness of the name is questionable.

The form *ferrugineoides* Gn. has the outer half of the fore wing contrasting, solidly gray or gray-black (rarely shining black), the markings obscured basad to the medial shade. The hind wing is heavily shaded with gray from the postmedial outward, basad variable but always decidedly lighter, corresponding

to the effect on the fore wing. This hind wing pattern is constant, unlike the typical form which is variable, but never shows this pattern.

The form *ferrugineoides* is rare in southeastern Pennsylvania, constituting slightly over one per cent. of the 7000-plus specimens I have examined since 1961. Its frequency has not varied significantly over this period, although the population expanded greatly in 1963 and remained at above-normal levels in 1964.

Fully developed *ferrugineoides* has not been seen from Philadelphia and the surrounding counties, though it does occur at least as far east as Dauphin County. Philadelphia-area specimens show the contrasting outer half a greasy-looking fuscous, thin enough that the gray spot in the lower part of the reiform, and often the subterminal line, can be detected with little difficulty; rarely all the markings are traceable. Such specimens are found with the fully darkened *ferrugineoides* where the form is commoner, as in western Pennsylvania and much of New York and New England.

These facts suggest that the light *ferrugineoides* from Philadelphia and elsewhere are heterozygotes, and that the form is controlled in a simple way genetically. With so low a heterozygote frequency, the lack of homozygotes would hardly be disturbing (assuming the Hardy-Weinberg law applies). This hypothesis has been confirmed by breeding.

A female *ferrugineoides* already mated to a wild male of unknown phenotype was obtained at light in 1961 and confined. 78 ova were obtained. The eggs were placed outdoors and the larvae sleeved on maple (*Acer saccharium*) the following spring. A total of 24 adults emerged in early August, several weeks before most wild individuals were flying. There were 11 *ferrugineoides* in the lot. Two sib matings within the typical part of this brood were obtained, with three within *ferrugineoides* and a cross of male *decipiens* x female *ferrugineoides*. They were treated in the same manner and gave adults in August-September, 1963. The results are shown in Table I, from which it may be seen that fully dark *ferrugineoides*, not seen wild locally, were produced and thus demonstrated the potential occurrence of that form locally. The graduation from darkest to lightest is continuous, the paler homozygotes and darker heterozygotes probably overlapping. One mating of two dark specimens was obtained, as well as one of a dark x light *ferrugineoides*. The resultant generation appeared in August, 1964 and is also given in Table I.

TABLE I

Genetic data on forms of *Sunira bicolorago* Gn.f. = *ferrugineoides*; b = *bicolorago*.

Mating	Expected Ratio	Brood Ratio	χ^2	P
1. ? x f. ♀ wild	1:1	11:13	0.666	.40 < P < .60
2. b. ♂ (1) x b. ♀ (1)	0:1	0:29	—	—
3. b. ♂ (1) x b. ♀ (1)	0:1	0:36	—	—
4. b. ♂ (1) x f. ♀ (1)	1:1	23:28	0.490	.30 < P < .50
5. f. ♂ (1) x f. ♀ (1)	3:1	20:6 ₁	0.051	.80 < P < .90
6. f. ♂ (1) x f. ♀ (1)	3:1	25:9 ₁	0.039	.80 < P < .90
7. f. ♂ (6) ₂ x f. ♀ (6) ₂	1:0	35:0 ₁	—	—
8. f. ♂ (5) ₂ x f. ♀ (6)	1:0	12:0 ₁	—	—
9. b. ♂ (3) x f. ♀ (5) ₂	1:0	27:0	—	—
10. b. ♂ (3) x f. ♀ (6)	1:0 ₃	56:0	—	—

₁ Includes fully dark individuals.₂ Fully dark individual (homozygote).₃ The female was apparently a light homozygote.

The hypothesis of a partially dominant "*ferrugineoides*" allele has thus been confirmed. At the same time, minor variation in the strength of the medial shade and subterminal shading in *bicolorago* was found to be continuous; no attempt was made to determine whether this variation was genetic or (as seems likely) at least partly environmental.

In the course of collecting a third, and radically different, ground-color form was found. No similar specimens could be located in the extensive series of the United States National Museum and American Entomological Society collections. This form is strikingly different in general facies from any other type of *bicolorago*. A description follows.

***Sunira bicolorago* form *brunnea*, f. nov.**

MALE. Ground-color reddish brown with a slight purplish tinge, about the color of *Crocigrapha normani*, the usual markings present and with the normal amount and type of variability in same, the dark pattern in heavy fuscous, with the light lines more or less contrasting, pale brown. Fringe fuscous, the usual light points at the veins preserved. Upper surface of secondaries variably dark gray with more or less of the postmedial line, as in the typical form, but darker; fringes mainly fuscous, paler than

on primaries. Under surface brownish pale fuscous with usually well-developed discal dot and postmedial line on all wings. Head, thorax, legs and antennae with usual orange, ochre or buff coloration replaced by reddish brown throughout; abdomen gray, lighter beneath, concolorous with the wings on both surfaces, the genitalic tufts ochre brown. Genitalia as in the other forms. Size variable, as in the other forms, generally ca. 26 mm.

FEMALE Not seen.

Types: Holotype male, Erdenheim, Montgomery Co., Pa., IX.26.64; paratypes: Conshohocken, Montgomery Co., Pa., X.3.64; Mt. Airy, Philadelphia Co., Pa., X.7.61; Wissahickon, Philadelphia Co., Pa., IX.28.63; Devon, Chester Co., Pa., X.4.63. Type to be deposited in the Academy of Natural Sciences, Philadelphia; paratypes presently retained by the author.

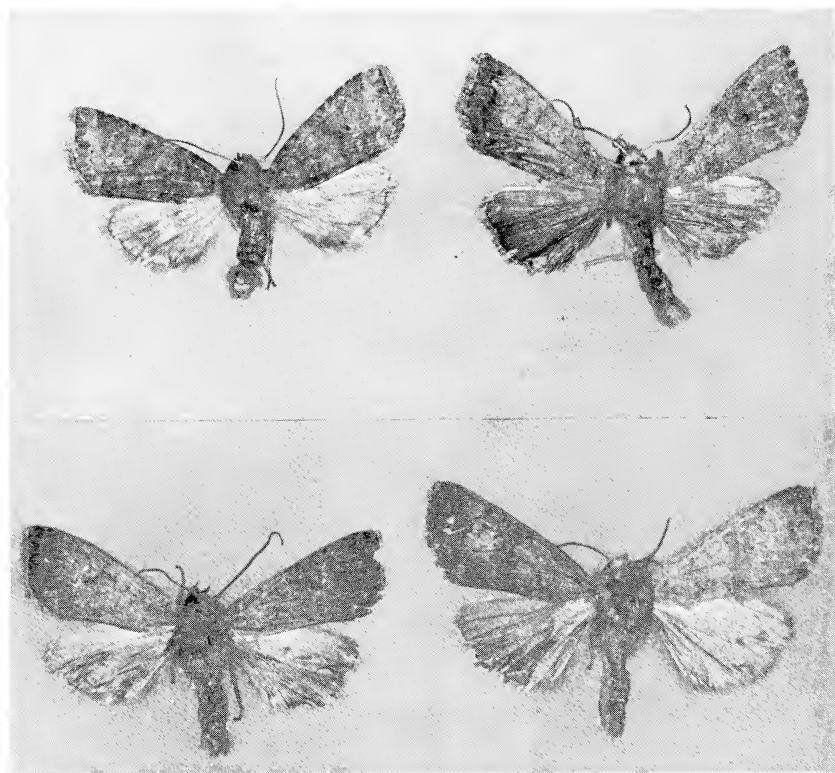


Fig. 1. Above: left: *Anathix puta* ♂. right: *S. bicolorago*, f. nov. *brunnea*. Below, typical *S. bicolorago*, Montgomery Co., Pa.

This form is easily separated from the others of its species, but is apt to be confused with a number of superficially similar Noctuids. It apparently can occur with the full range of variation within the usual types, the only difference being the brown color which, however, imparts to the insect a very distinct appearance. It is almost certainly genetic. If we assume it to be recessive, its frequency at Philadelphia and vicinity is between one and two per cent. Similar specimens almost certainly exist in various collections, unrecognized or confused with other species. There is a marked superficial similarity to *Anathix puta* G.&R., from which the form may be told quickly by the differently shaped postmedial, the less uniform brown color, and the lack of black points on the subterminal.

The *brunnea* form has not been seen in combination with *ferrugineoides*. This fact is hardly surprising, considering that *brunnea* almost certainly has a frequency or less than 2% in Pennsylvania, and *ferrugineoides* is as rare as it is. It is likely, however, that such a genotype can and does occur; the moth produced would probably be a most striking form, with brown basal and gray-black apical half of the fore wing, and a dark, two-toned hind wing. No intergrades, or anything approaching an intergrade, to the typical or other known forms, have been seen. The new form is separated from the darkest red specimens of other forms by a marked discontinuity. It clearly is not the extreme in a continuous variation.

At least the *ferrugineoides* form (and probably *brunnea*) of *S. bicolorago* represents an instance of dimorphism where relative frequencies of the various types vary with locality, reflecting differing selective pressures and adaptive values. More data on the relative frequencies of the forms in this widespread, abundant, and easily sampled species would be of considerable interest and value.

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ANTEPIONE THIOSARIA AND XANTHOTYPE:

A CASE OF MIMICRY

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MIMICRY BEING THE CONTROVERSIAL PHENOMENON it is, the existence of an apparently undescribed case in so well-documented a fauna as that of eastern North America comes as a distinct surprise. The case in question involves a number of special circumstances which greatly enhance its interest and which may have contributed to its nature not having been recognized previously. The insects involved are the species of *Xanthotype* as the presumed models and *Antepione thiosaria*, the mimic (all Geometridae).

Xanthotype is a North American genus of several sibling species, frequently determinable only by the genitalia. All are bright yellow marked with light violet-brown in the manner of the specimens shown in Fig. 1 (right). *A. thiosaria* is an outlier of the large Neotropical *Sabulodes* group, and is distinctive within that group in being strongly seasonably dimorphic; the summer form departs widely from the usual appearance of its relatives, while the spring form is fairly normal. The two genera are in the same subfamily but different tribes (Angeroniini and Ourapterygini respectively) and are not considered closely related.

The spring form of *A. thiosaria* (Fig. 1, left) flies in April and May through most of the range. It is fawn color, about like the related *Prochoerodes transversata* Dru., with no strong contrasts, and a definitely concealing coloration. The summer form (Fig. 1, center) flies in July and August. It shows marked sexual dimorphism (unlike the earlier brood). The male is bright yellow with a red-brown to chocolate-brown border covering the outer half of the wings. The female is entirely bright

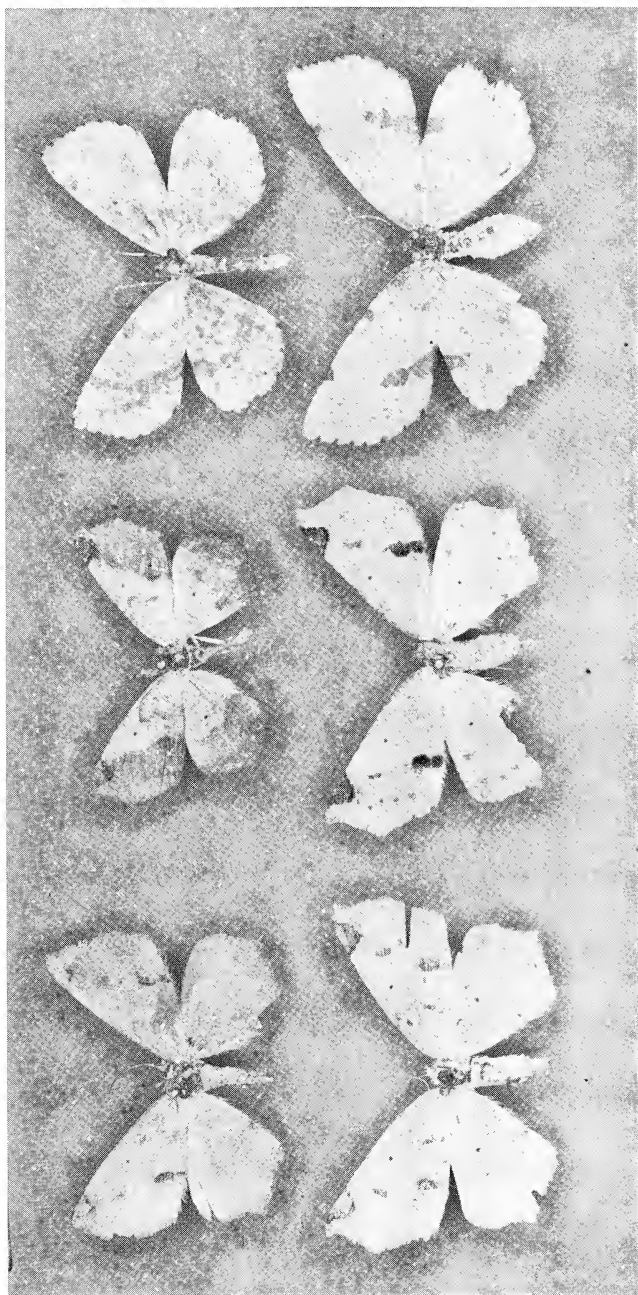


Fig. 1. Left: *Antepione thiosaria*, spring form, Montgomery Co., Pa., V. 1963. Center: *A. thiosaria*, summer form, do., VII. 1964. Right: *Xanthotype sospeta*, do., VII. 1964. Males above, females below.

yellow, without the contrasting border, but with purplish markings representing parts of the complete pattern, and very closely approximating the pattern of the species of *Xanthotype*. Intergrades between the summer and spring forms occur, but are rare. The difference in coloration is controlled entirely by the temperature environment of the pupa.

The limitation of the resemblance to *Xanthotype* to the summer brood of *thiosaria* becomes more reasonable when the flight periods of the presumed models are considered. In the northeastern United States there are two *Xanthotype*: a very abundant univoltine species (*sospeta* Dru.) and a variably common bivoltine one (*urticaria* Swett). The relative numbers of the two vary from locality to locality, but both are usually present. Their flight periods are essentially constant throughout the range. Fig. 2 shows the flight periods of these two

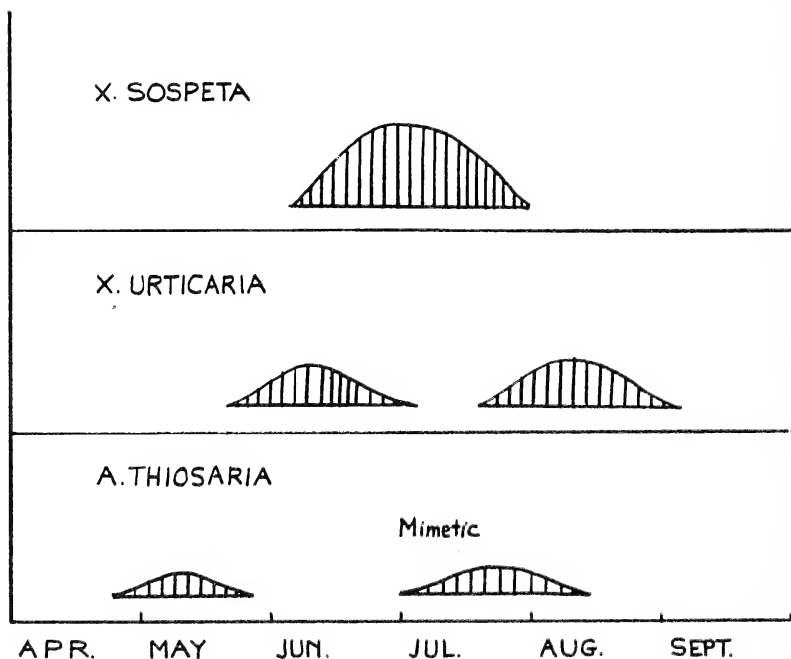


Fig. 2. Flight periods and relative abundance of models and mimic in Pennsylvania.

insects and the presumed mimic in Pennsylvania; they may be taken as representative. The relative abundance shown is average for that State. From Delaware south there is another species, *X. rufaria* Swett., univoltine with the flight in June in Florida and South Carolina and late June-early July in Delaware and Maryland. *A. thiosaria* ranges south to Tennessee and (reported from) northern Mississippi.

It is quite clear that the summer flight of *thiosaria* coincides with the second half of the flight of *sospeta* and the first of the second brood of *urticaria*. The non-mimic spring brood of *thiosaria* generally does not overlap any *Xanthotype* at all.

There are no records available on the palatability of the species of *Xanthotype*. Its conspicuous coloration and behavior suggests, however, that the genus is highly protected. The moths are partially diurnal. They normally sit in low vegetation during the day, with some spontaneous flight activity in the early morning and in the evening, and occasionally in bright sunlight. They are often to be found at rest in exposed situations. When aroused from rest their flight is sluggish and conspicuous. *A. thiosaria* is nocturnal and rests in low vegetation and on the ground by day. It is generally better concealed when at rest than are the species of *Xanthotype*. When alarmed its flight is quick and active, but its coloration (particularly that of females) is fully as conspicuous as that of the probably protected species.

It is quite possible that the failure to copy the flight characteristics of the model reflects the seasonal coloration switch from a concealing to a mimetic pattern; the spring form must move quickly. The resemblance in flight, especially in the female *thiosaria*, is very striking nonetheless and often the two cannot be discriminated with certainty until in the net.

The patterns of nocturnal moths are generally assumed to have evolved in response to visual-predation selective influence operating in daylight, when the insects are at rest. All the evidence so far available suggests that coloration has no role in the activities of moths which are carried out in darkness (e.g. in mating; the striking absence of conspicuous sexual dimorphism in most nocturnal moths bears witness to this), or in nocturnal predation. The failure to recognize the existence of mimicry in nocturnal moths has probably resulted from an incomplete appreciation of this fact.

The opportunity for *thiosaria* to benefit from its resemblance to *Xanthotype* is enhanced by the habit, shared by both, of

walking about and waving the wings prior to taking flight (except when extremely agitated). This activity is most conspicuous when the moth had been resting on the ground or otherwise in a fairly open situation. In the absence of further provocation the moth may settle again without taking flight. A bird conditioned to avoid the *Xanthotype* color and pattern might then not have to startle the insect or actual flight to be deterred from eating it. This walking-waving behavior is found in a variety of Geometridae, including such diverse groups as *Eranis* and *Semiothisa*, but not in the immediate relatives of *Antepione* (*Prochoerodes*, *Abbotana*) in North America, at least.

The sexual dimorphism of summer *thiosaria* may reflect a recent origin for the mimicry (as does, perhaps, the lack of summer flight modifications). Female mimetism is, however, quite common and well known in the Lepidoptera (e.g., the famous *Papilio dardanus*, and the presumed mimic *P. glaucus* and *P. polyxenes* in the U.S.A.). The male *thiosaria* is really a fairly effective copy of dark male *Xanthotype* in flight and when walking-waving; certainly more so than the set specimens would indicate. The inferiority to the resemblance in the female is, however, very evident.

So far as is known, *thiosaria* is always less abundant than the local *Xanthotype*, and sufficiently so to make the resemblance profitable and prevent counterconditioning. At Philadelphia, Pa. the overall ratio is usually about 7.5:1; in eastern Maryland, about 12:1; in central Massachusetts about 7:1. (Light-trap data are not in themselves reliable since *Xanthotype* are less attracted to both white light and UV than is *A. thiosaria*.) In practice, predators may have considerably less contact with the mimic than even its numbers would indicate, since its habits by day are much more secretive than those of the model and the resemblance is shown conspicuously only in time of peril.

In summary, then, the postulated mimicry association fulfills the fundamental requirements for such a relationship, viz.:

1. The (presumed) model exhibits bright, warning-type coloration, and its behavior indicates that it is highly protected.

2. The presumed mimic has departed significantly from the normal coloration of its relatives (and in this case, in having a marked seasonal dimorphism).

3. The mimic is sufficiently rare in comparison to the model to insure an advantage to the former.

4. The two insects are properly associated spatially (sympatric) and temporally (synchronous, or the model partially preceding the mimic).

5. The resemblance is conspicuously displayed to potential predators.

The case of *Antepione thiosaria* seems to be the only described instance where mimicry is confined to one of multiple generations, coinciding with the active period of the model. It also is the only described case where the mimetic coloration is produced by an environmentally controlled switch mechanism defined genetically, instead of by a direct genetic morphism. This is a common device where different phenotypes have different values in the various generations, and its application to mimicry was predictable. The case of *A. thiosaria* is probably far from unique, although the utilization of a seasonal mechanism would not be expected in the humid tropics where so many mimicry associations occur; further examples are to be sought primarily in temperate areas.

CORRECTIONS

Misplacement of one page in the makeup of the paper by
PADDY MCHENRY entitled

THE GENERIC, SPECIFIC AND LOWER CATEGORY NAMES OF THE NEARCTIC BUTTERFLIES

PART 3 - Argynnis

published in this JOURNAL, 3(4): 231-268, 1964 has caused
considerable confusion. Our apologies are extended to all.

Page numbers should be changed as follows:

245	should be	250
246	"	245
247	"	246
248	"	247
249	"	248
250	"	249
251	"	252
252	"	251

While the opportunity is also available, a typographical
error may also be corrected. On page 267 under number 8,
Tomes 1-2 should read Tomes 1-12.

1160 W. Orange Grove Ave., Arcadia, California, U.S.A.

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THE ALTERATION OF HOST PLANT SPECIFICITY IN LARVAE OF *PIERIS RAPAE* BY INDUCTION¹

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The Lepidoptera Foundation, Arcadia,
and
The California State College, Los Angeles

THE PURPOSE OF THE EXPERIMENTS described in this paper has been to illustrate how the larval selections of particular strains of *Pieris rapae* can change their preferences over a period of time according to the food plants on which they have been bred. It has already been shown that strains of this insect favor a plant on which the larvae have been bred, whether the exposure has been of short duration (less than one generation) or of long duration (over one generation).

The present experiments differ from those previously made in that the strains used are either deliberately confused as to preference (by hybridization or changing of food plants), or by selection for many generations on a different plant.

ORIGINS OF STRAINS OF *PIERIS RAPAE*

Four series of tests were made in the experiments; one series was bred on black mustard for several generations, one on kale, one on nasturtium and one was bred on *Isomeris*.

The black mustard strain was derived from hybrids between kale-and-mustard-strains as described before (Hovanitz and Chang 1963). They were confused as to food plants, both by hybridization and by breeding for six generations thereafter on a variety diet of mustard, nasturtium and *Isomeris* before the commencement of the tests described below.

The kale strain was derived from a strain grown on mustard for many generations.

The nasturtium strain and the *Isomeris strain* were both derived from a strain grown on kale for many generations. These original strains are described in a previous paper (Hovanitz and Chang 1964).

¹Aided by a grant from the National Science Foundation.

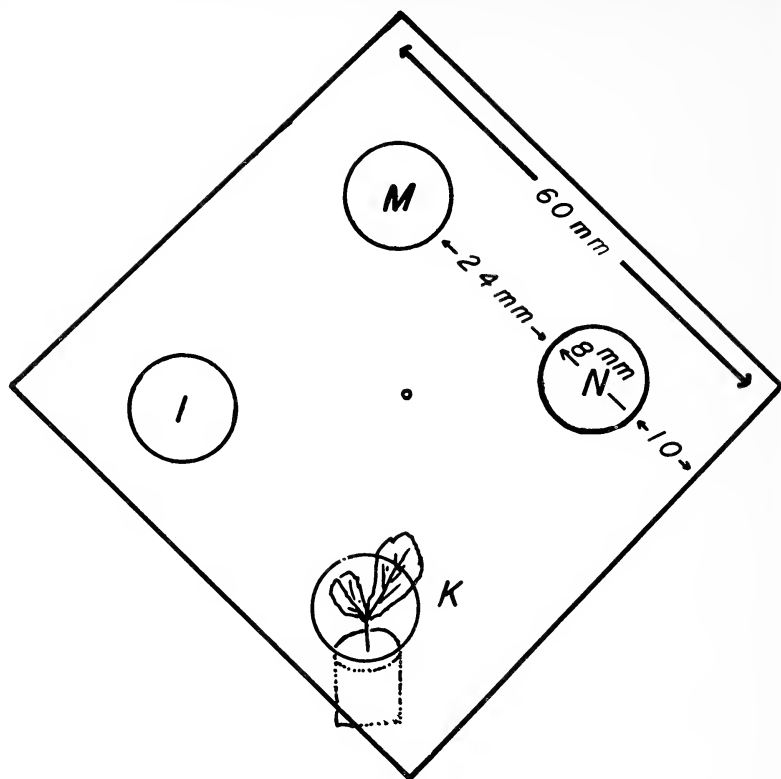


Fig. 1. Diagram showing the set-up of the selection experiments. M = mustard, I = *Isomeris*, N = nasturtium and K = Kale.

PROCEDURE

The larvae used in these tests were raised exclusively on one of the following plants: black mustard, kale, nasturtium and *Isomeris* for the number of successive generations indicated in the description below.

The test procedures were the same as those described in the previous paper (Hovanitz and Chang, 1962). The setup, however, was changed slightly. Four different potted plants, about the same size (mustard, nasturtium, kale and *Isomeris*) were placed under a wooden platform, the leaves and the stems extending through the holes and above the surface of the platform as shown in fig. 1. In the test, generally more than ten middle sized larvae (14mm to 16mm in length) were placed in the central area shown by a small circle and allowed to go to the plants or to leave the platform. Each larva was tested 20 times.

THE SELECTED STRAINS

ON BLACK MUSTARD: The first generation larvae of this strain had a nearly equal selection for mustard, kale and nasturtium (Table 1, Fig. 2) but little selection for *Isomeris*. The trend during eight generations of selection was up for mustard and down for nasturtium. For the first five generations, selection was down for kale and thereafter up. No obvious reason can be given for the latter result.

ON KALE: The first generation on kale (after having been on mustard for many generations) indicates highest selections on mustard (Table 2, Fig. 3). For over fourteen generations, selections decreased for mustard from 57 percent to 25 percent but increased for kale from 24 percent to 55 percent; this is a complete reversal of selections for these two plants. Selections for nasturtium and *Isomeris* did not change appreciably during this time.

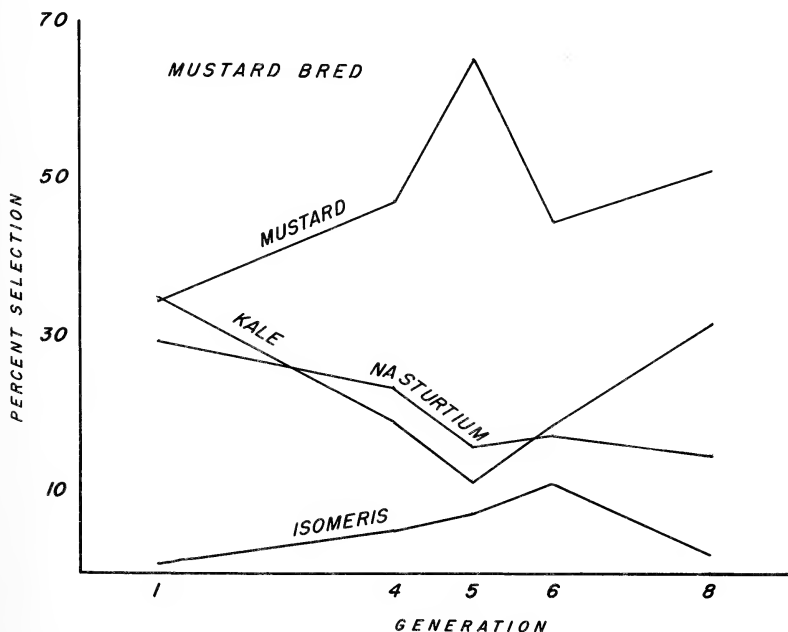


Fig. 2. Food plant selections by larvae of *P. rapae* fed black mustard.

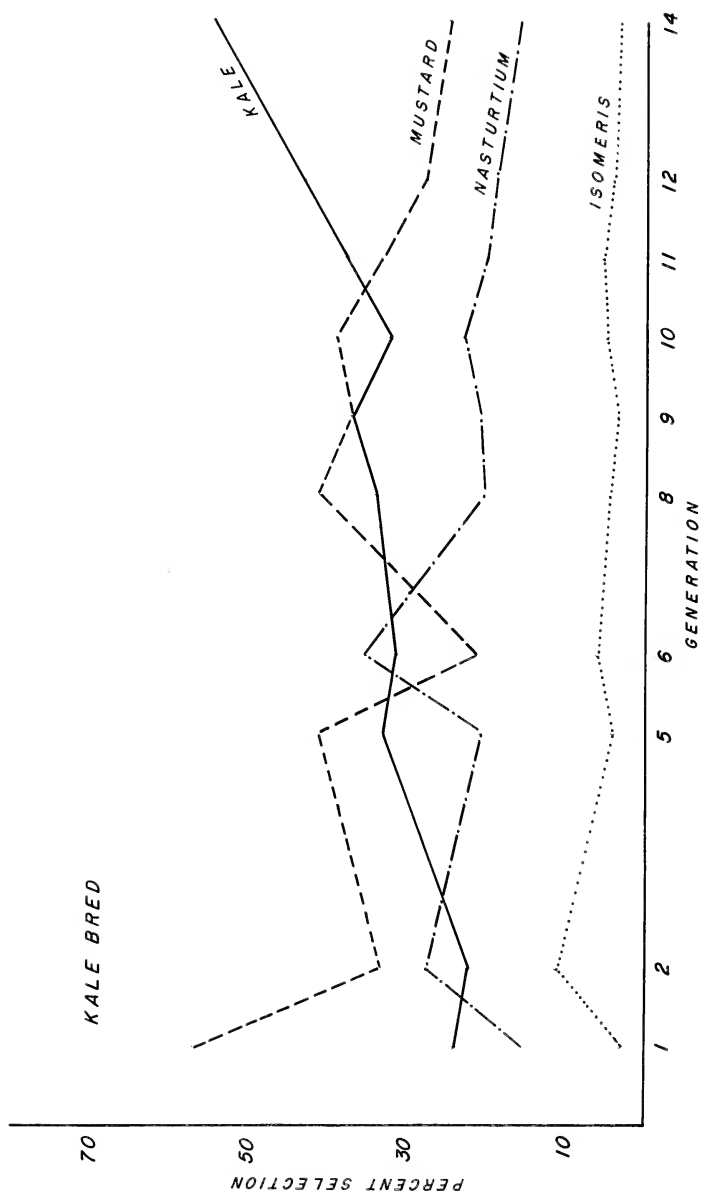
Fig. 3. Food plant selections by larvae of *P. rapae* fed kale..

Table 1. Food plant selections by larvae of Pieris rapae fed black mustard (Brassica nigra)

Generation	Mustard		Kale		Nasturtium		Isomeris		None	
	N	%	N	%	N	%	N	%	N	%
1st	69	34.5	70	35.0	59	29.5	2	1.0	0	0
4th	226	47.1	95	19.8	113	23.5	26	5.4	20	4.2
5th	182	65.0	32	11.4	45	16.1	21	7.5	0	0
6th	133	44.3	56	18.7	52	17.3	34	11.3	25	8.3
8th	122	50.8	76	31.7	35	14.6	5	3.1	2	0.8

Table 2. Food plant selections by larvae of Pieris rapae fed kale (Brassica oleracea var. acephala)

Generation	Mustard		Kale		Nasturtium		Isomeris		None	
	N	%	N	%	N	%	N	%	N	%
1st	160	57.1	68	24.3	44	15.7	8	2.9	0	0
2nd	96	34.3	63	22.5	78	27.9	32	11.4	11	3.9
5th	83	41.5	67	33.5	42	21.0	8	4.0	0	4.6
6th	52	21.7	76	31.7	86	35.8	15	6.3	11	4.6
8th	90	40.9	75	34.1	45	20.5	10	4.6	0	0
9th	97	37.3	97	37.3	55	21.2	9	3.5	2	0.8
10th	102	39.2	84	32.2	61	23.5	13	5.0	0	0
11th	81	33.8	92	38.3	49	20.4	14	5.8	4	1.7
12th	129	28.0	198	43.0	89	19.3	20	4.4	24	5.2
14th	55	25.0	120	54.5	36	16.4	7	3.2	2	0.9

ON NASTURTIIUM: The second generation on nasturtium (after origin on kale) gave highest selections for kale and second highest for nasturtium (Table 3, Fig. 4). For over eight generations, selections decreased for kale (from 43 percent to 17 percent) and increased for nasturtium (from 16 percent to 40 percent). Selections for *Isomeris* and mustard did not change appreciatively.

ON ISOMERIS: The second generation on *Isomeris* (after origin on kale) gave highest selections on kale (33 percent), second highest on nasturtium (30 percent) and third highest on mustard (25 percent) [Table 4, Fig. 5]. By the sixth generation, there had been an increase in selections for *Isomeris* (from 9 percent to 22 percent), a decrease for kale (from 33 percent to 17 percent), a slight increase for mustard (25 percent to 32 percent) and only an enatic change for nasturtium.

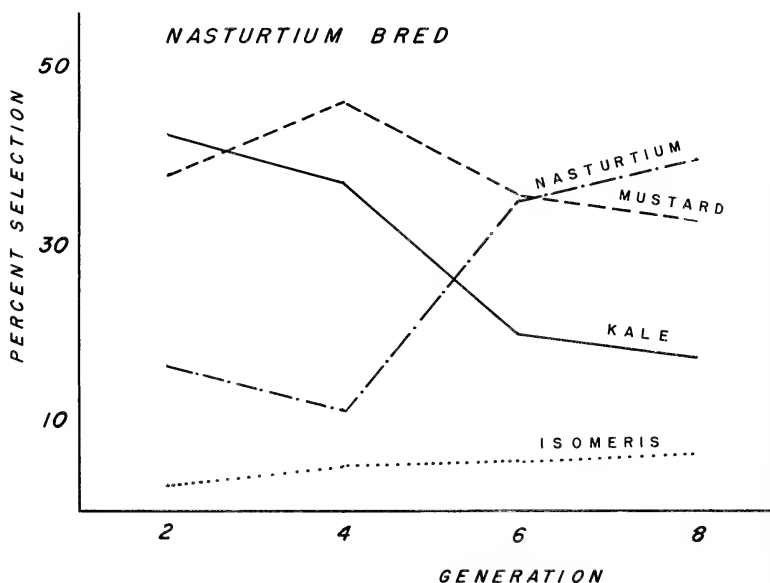


Fig. 4. Food plant selections by larvae of *P. rapae* fed nasturtium.

Table 3. Food plant selections by larvae of Pieris rapae fed garden nasturtium (Tropaeolum majus)

Generation	Mustard		Kale		Nasturtium		Isomeris		None		Total
	N	%	N	%	N	%	N	%	N	%	
2nd	53	37.9	60	42.9	23	16.4	4	2.90	0	0	140
4th	111	46.3	90	37.5	27	11.3	12	5.0	0	0	240
6th	94	36.2	52	20.0	93	35.8	15	5.8	6	2.3	260
8th	133	33.3	69	17.3	161	40.2	26	6.5	11	2.7	400

Table 4. Food plant selections by larvae of Pieris rapae raised on Isomeris arborea

Generation	Mustard		Kale		Nasturtium		Isomeris		None		Total
	N	%	N	%	N	%	N	%	N	%	
2nd	60	25.0	78	32.5	72	30.0	21	8.8	9	3.8	240
4th	74	28.5	88	33.8	44	16.9	43	16.5	11	4.2	250
6th	77	32.1	41	17.1	59	24.6	52	21.7	11	4.6	240

DISCUSSION

The results of these experiments indicate that food plant selections by a phytophagous insect are inherited and that they may be altered first in one direction by change of food plant and then in the other direction.

It is apparent too that food plants which are not normally desirable (such as *Isomeris*) can become at least a potential food plant, even if not greatly desired.

It seems likely that in a genetic sense, these strains never become homozygous, or pure, strains. This is shown by the fact that a strain which by selection has been developed for a preference toward kale can be reversed to a preference toward nasturtium. It seems highly possible that chromosomal genes are not involved in the type of selection being considered here, but there is no answer to the question of what the mechanism of the inheritance is. Change in selection of plants during the course of a single generation as shown in a previous paper (Hovanitz and Chang 1963) is another point that must be brought into consideration as regards the mechanism of this effect.

The genes obviously do not change, only the physiology and chemistry of the cells in the individual. This "transference of induced food habit" (Sladden, 1934) is a biological principle

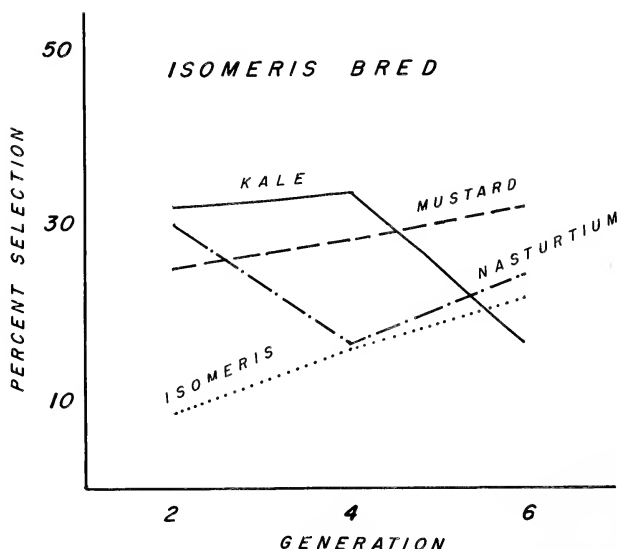


Fig. 5. Food plant selections by larvae of *P. rapae* fed *Isomeris*.

which is as yet not understood, either within the single generation or between successive generations. Simple inheritance may not be involved.

SUMMARY

Four strains of *Pieris rapae* have been altered in their food plant preferences by "induction". By this is meant that the largae have been induced to prefer a particular plant. The results indicate that if a larva is induced to prefer a particular plant, it's "transduced" adult also prefers that plant for oviposition; this transduction is passed on to the next generation and to all subsequent generations until the trait is again induced to change.

The four strains used in these experiments were fed on mustard, kale, nasturtium and *Isomeris*. Each of these strains gained a preference of the food plant on which it was fed, or at least gained a greater preference for it than it had before the induced effect.

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THE CLIMATOLOGICAL TOOL IN LEPIDOPTERA RESEARCH

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THE PURPOSE OF THIS ARTICLE is to discuss sources of raw climatic data, to acquaint Lepidopterists with climatology, to develop a few procedures that would be useful to research on the Lepidoptera, and to describe briefly some paleoclimatology and automation techniques.

Some illustrative examples are provided that utilize climatic data, though it should be kept in mind that the figures are based on the few local distribution records at my disposal; values would probably vary considerably if a large volume of data from throughout the species range were considered. Being more familiar with species and climatic conditions in Oregon, material treated will primarily concern the Pacific Northwest, but could be applicable on a much broader scale.

DATA SOURCES

The basic data for an involved climatic study may be mostly obtained from three government publications: *Climates of the States*, *Climatological Data*, and *Climatic Summary*. All are published in sections—a state, territory, or group of states.

Climates of the States. This publication is probably the best general source of climatic data for those not familiar with climatology. The climate of particular sections is generally described, with references and bibliography to indoctrinate the reader with that section's climate. The long-term annual and monthly mean values of precipitation and temperature are listed for several stations within each section's climatic divisions. Freeze data and growing season length are reported also for representative stations. For all U. S. Weather Bureau stations within the section, data concerning snowfall, humidity, wind, and cloudiness are compiled. Five maps are given with isolines for January and July mean maximum and minimum temperatures,

and for mean annual precipitation. For a detailed analysis of the climatology of a region, it is found that the material in the publication is insufficient.

Generally unknown to most, the United States is literally blanketed with a network of cooperative climatological stations. The observations at these stations generally consist of a daily reading of maximum and minimum temperatures, precipitation amounts, and snow depths.

Data for the cooperative stations may be found for periods prior to 1955 in the *Climatic Summary*. This publication (actually two, a 1930 edition, and a 1931-1955 supplement) is concerned mostly with precipitation, giving monthly and annual amounts by year. Temperature and snowfall are listed only as a long term normal of that station. A station directory and history is included also.

Climatological Data. This is a monthly and annual publication listing all pertinent climatic data for the month, with an annual summary. Temperatures are here listed by each year. Daily precipitation is also given in this publication.

Of interest also is *Local Climatological Data*, and *Climatological Data National Summary*. The former gives local data, monthly and annually, for each Weather Bureau Station, and the latter a general summary of the U. S.

General background material on most phases of climatology may be obtained from *Climate and Man*. This book covers a very broad range of meteorological subjects from flooding to paleoclimatology, besides giving a climatic summary of each state with maps. This information is somewhat dated though, and should be accepted only as a guide

CLIMATIC DISTRIBUTION

Clench, in an earlier (Sept. 1963) issue of this journal, concerning climatic adaptation, stated "The various factors which together make up what we call climate exert a strong control over the distribution of Lepidoptera. . .". This statement, in effect, is very valid, and I should assume that the probable distribution of most species may be determined solely on the basis of climatic limitations. Often, other factors, such as foodplant availability, or geographical barriers may alter the picture somewhat, or in other cases, species are found to inhabit wide climatic zones and be very widely distributed. In all cases though, a species is limited between a maximum and minimum range of climatic factors, and probable distribution may be predicted by comparing collecting sites with climatic data.

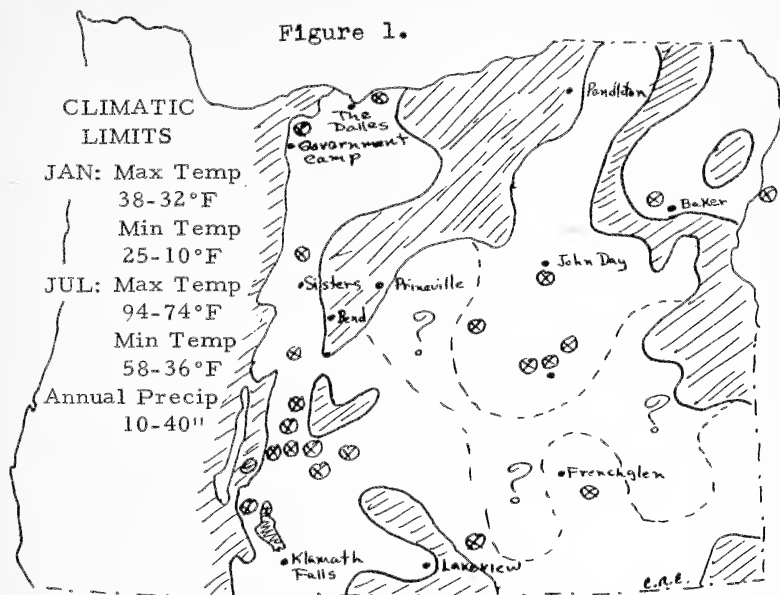


Fig. 1. Probable Distribution of *Callopsyche behrri* in Oregon, based on climatic means. Shaded area presumably unavailable to *behrri*. X indicates locality from which specimens have been reported.

Figure 1 is a sketch of the probable distribution of *Callopsyche behrri* in Oregon, based on an accumulation of some twenty localities. The localities were plotted on each of the five maps in *Climates of the States-Oregon*, and all values outside the maximum and minimum departure were shaded out. This distribution of many species may be determined solely on the basis of climatic means. Elevation (maximum observed 7000'-Steens Mts.) was not plotted due to the small aerial coverage of 7000' plus values in the unshaded areas. A questioned area of precipitation from 8-10" may be revised by the discovery of a specimen in these limits. The area is shaded only on the strength of all specimens falling at an annual mean precipitation value in excess of ten inches. In areas of eight inches and under, temperature again becomes a second barrier (in Oregon—maybe different elsewhere, the whole range should be considered).

Clench (Sept. 1963) used a similar approach in constructing a distribution diagram of *Callophrys sheridani* for the Pacific Northwest. Had values from *Climates of the States* been utilized, rather than from *Climate and Man*, perhaps a more realistic distribution pattern might be realized.

When a large amount of butterfly locality data is available, a distribution map with a low probability of errors may be constructed by reanalyzing the available climatic data. If then, in the course of investigation a standard series of mean values is adopted by the individual (as for the period 1953-1962 for this example, though any period of any length may be utilized), it will be found in the *Climatic Summary* and *Climatological Data* that cooperative climatic stations have opened or closed, before, during or after the "standard" period.

To obtain more realistic mean values, all stations, past and present, in operation are plotted on a topographic chart, those having "standard" means being so designated. Generally speaking, by computing the ratio of contemporary data in "on-standard" years for closed stations, realistic adjusted means may be determined for most nearby stations with similar climatic conditions. Generally, computed correlations for nearby eastern

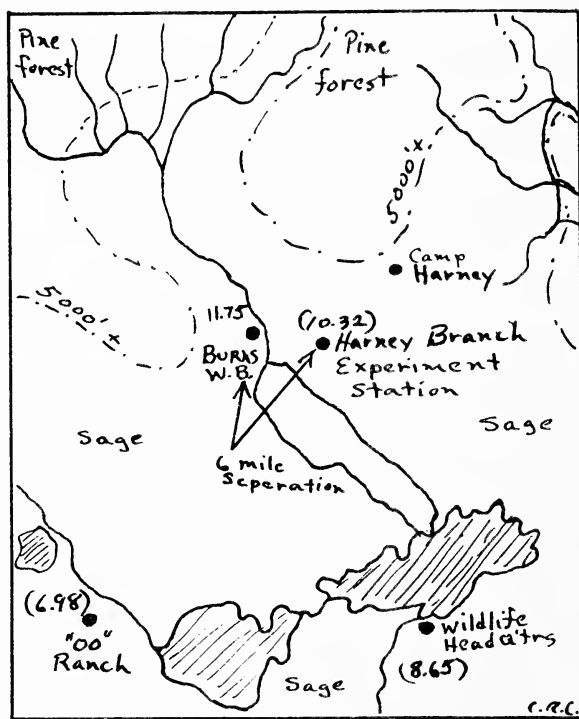


Fig. 2. The geographic relationship of two climate stations with the annual precipitation over a standard period for Burns known, and nearby stations being estimated by ratio.

Oregon stations, indicate a high degree of similarity, with values of 0.75 and above, except for a few stations existing, and closed, in the 1800's. Using this data, figure 2 shows the geographic relationships between two stations, and precipitation for these stations is determined from data and ratio computations found in table 1.

Table 1

Measured annual precipitation for two eastern Oregon meteorological reporting stations, and the ratio computations necessary to estimate a period of "standard" missing data for the period 1953-1962.

	Harney Branch Exp. Station	Burns W. B. (long term)
1937	12.93	11.48
1938	10.40	9.55
1939	5.82	5.92
1940	15.89	16.89
1941	13.36	14.92
1942	13.13	14.10
1943	6.83	7.28
1944	9.20	10.17
1945	12.75	13.35
1946	8.78	10.18
1947	10.58	12.36
1948	10.93	14.39
1949	3.70	5.28
1950	10.05	11.54
1951	9.32	12.55
1952	7.91	11.20
1953	<u>9.47</u>	<u>13.63</u>
1954		7.51
1955	$\frac{H'}{n} = 10.06$	$\frac{B'}{n} = 11.45$
1956		12.65
1957		13.45
1958	Station closed	12.84
1959	in 1954; H = ?	9.64
1960	$\frac{B}{n} = 11.75$	12.77
1961		10.77
1962		<u>12.07</u>

standard mean

$$\frac{B'}{B} = \frac{H'}{H} \quad H = 10.32''$$

On occasion computed values will appear that vary from nearby values considerably (as was the case with previously mentioned stations with values in the 1800's), probably due to changing ecology, instrument types, or changes in position of the station locally. If in doubt, correlation coefficients may be computed (0.60 appears to be significant), or the data disregarded. If the latter, one should keep in mind Paul Grey's (1959) suggested formula: $m \text{ plus } t = CS_2$.

In many cases, a relationship between precipitation and temperature may be expressed graphically. In figure 3 then,

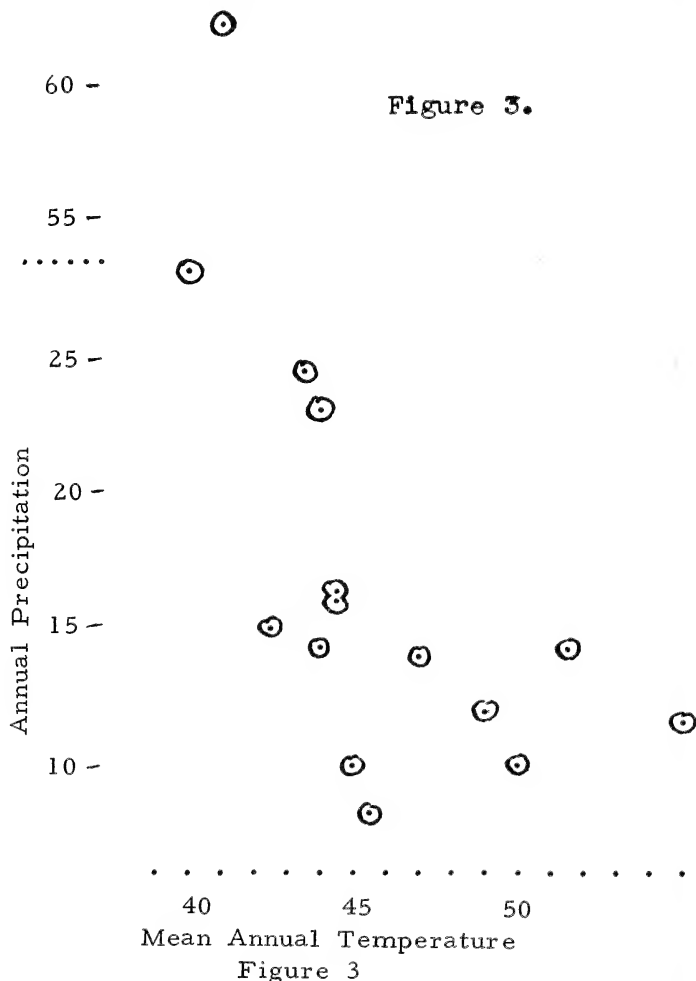


Fig. 3. Scatter diagram of climatic values for year of capture of *Callopsyche behrii*.

data from the year of capture for each locality of *Callopsyche behrii* is plotted. Data is of course insufficient, but generally, from the graph one would expect annual precipitation to decrease as temperature increases, with a rather broad cluster area.

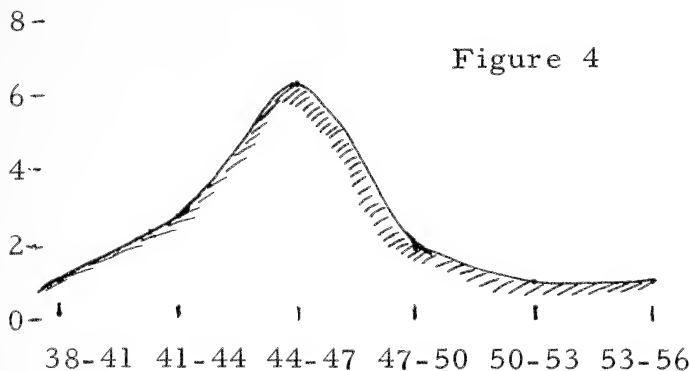


Figure 4

Fig. 4. Frequency diagram of *Callopsyche behrii*, plotted against annual mean temperature of year of capture.

Figure 4 is a frequency polygon for year of capture of *Callopsyche behrii*, with annual temperature as the X-axis, and frequency for the Y-axis. A sharp peak is noted in the 44-47 degree area. Again more data would perhaps make the curve more symmetrical, rather than skewed.

CLIMATIC FACIES VARIABILITY

It is often noted that facies appear to vary with different climatic conditions. In some cases, climate may not be the primary shade limitation factor, but graduation limits may be generally definable by correlation with climatic means.

It is probable then, that when standard methods of measuring variability in facies is determined, that many graduations may be geographically defined by climatic correlation. Probably one of the reasons for the apparent lack of present interest in this area is that if a correlation does exist, it is still difficult to prove that climate is the influencing factor inducing the variation. Many will argue that genetic factors are the primary variational factor (temporarily disregarding topographic barriers), rather than environmental conditions, but it is probable, in either case, that the two are either directly or indirectly linked, depending on the species considered, and results would be similar for environmental or genetic variations.

Subspecies and minor variations are affected in the same manner as general variation, in most instances. In figure 5 I have plotted the mean annual precipitation against the mean January minimum temperature for three northwestern varieties of *Coenonympha*. At once it is noted that *C. elko* and *ampelos* have roughly defineable climatic limits, and cluster rather well. On the other hand, the variety *californica* is apparently not affected by these particular limitations. The high precipitation values for *C. elko* is due to capture localities on wet eastern Cascade slopes.

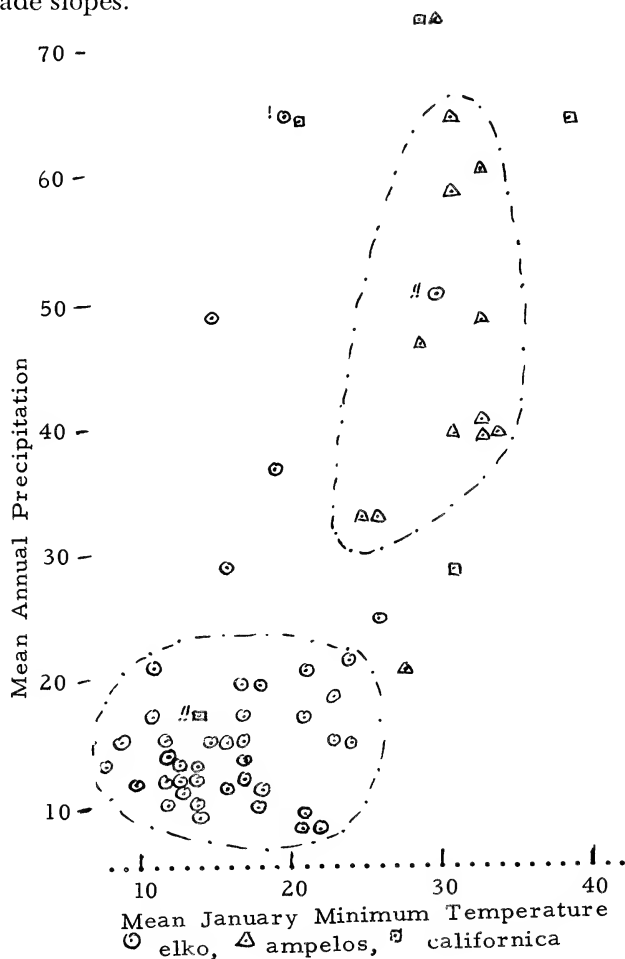


Figure 5

Fig. 5. *Coenonympha* scatter diagram, based on long term climatic means.

OTHER DATA OF INTEREST

Most mountainous areas have snow courses in which measurements of depth and water equivalent are taken during the winter months, for water supply forecasting. This data is published and offers information for determining approximate precipitation and snowfall values for these areas.

During the summer months, most U. S. Forest Service lookout stations keep records of temperature and precipitation. Although not officially published (to my knowledge), this data would presumably be available on request at the district headquarters, and would offer clues in determining climatic conditions at collecting sites.

The transition between Hudsonian life zones and arctic-alpine areas is more or less sharply defined in mountainous areas at specific elevations. As lower temperature limits to the arctic area may be roughly defined as about a mean annual temperature of 35-40 degrees, another clue may be added for those localities in mountainous areas. By comparing temperatures with a climatic station at the base of the mountain then, a graduated temperature diagram by altitude may be used as an estimate for temperatures about the perhipicy of the mountain and on the slopes. Standard lapse rates are rather unreliable due to changes in local topography, storm patterns, solar insolation, and elevational differences in foilage cover.

A definite correlation has been found to exist between annual precipitation (also temperature to some extent), and the thickness of annual tree rings. At some future date then, collectors might be asked to bring cuttings from specified collecting localities. In mountainous areas, this may prove to be the only reliable method of obtaining precipitation values for that site.

Besides temperature and precipitation, many other climatic factors exist that should be of interest to collectors. Areas like solar radiation, cloud cover, growing season and freeze dates, snowfall, winds, humidity, pressure and storm patterns, extreme temperatures, and the like are relatively uninvestigated, in relation to butterflies.

The interested reader is urged to obtain free of cost from the Superintendent of Documents, Government Printing Office, Washington 25, D. C., price list number 48, titled *Weather, Astronomy and Meterology*. This describes the earlier mentioned publications, besides other pertinent material available concerning meterology and climatology.

PALEOCLIMATOLOGY

In recent years, authors are becoming increasingly more aware of the significance of paleoclimatological events, as concerns present subspeciation and distribution. Phrases such as "refugia" are being considered with significance during Pleistocene (Ice Age) ice advances, as are "mass population movements", retreating or advancing in rhythm with thrust stages of glacial ice.

Climatic events prior to the Pleistocene, over the arid Pliocene and damp Miocene, probably are of little significance to our present biological situation, even though fossil evidences shows butterfly existence much earlier. The climatic pattern assumes probable importance at the beginning of the Pleistocene then, some 1,000,000 years ago, and marked the end of some 12,000,000 years of relatively consistant dry climate.

The arctic ground far south, invading the northern U. S. and dropping temperatures considerably from the present normal. Those areas not covered by ice suffered pluvial rains of long and heavy duration (estimated to be 2-3 times the present normal). In my own area, lobes of the great Cordillian Ice Sheet, of British Columbia, pushed as far south as Spokane, and the Vashon sheet past Olympia in Washington. Mountain glaciers were carving moraines in the Steens and Wallowas of Oregon, while extensions of inland seas filled the low eastern basin areas, forming Lake Lahontan. Volcanoes were covering millions of acres in the Cascades and eastern Oregon with sterile pumice, besides leaving thick successive layers of basalt and andesite.

With drastic Quaternary events, the butterfly populations undoubtedly suffered greatly, and the collector is tempted to speculate on conditions affecting certain species. In some instances this speculation has been fruitful, as with Clench's (Dec. 1963) treatment of west Indian *Lycaenidae* during the Wisconsin maximum.

Figure 6 is an Oregon-Washington map of the Wisconsin maximum around 14,000 years ago. As is noted at the present, the Oregon Cascades north of Crater Lake are relatively poor in butterfly fauna. As can be seen from the Pleistocene volcanic activity (not necessarily contemporaneous) the bulk of the Cascades would be rendered unfit for arctic species following the ice south, while sterile pumice areas would prevent a northern movement of southern species during inter glacial times. A

- Wisconsin 32° January maximum
- Present 32° January maximum
- - - - - Wisconsin Arctic-alpine areas
- ☼ Present Arctic-alpine areas
- ▨ Pleistocene basalt and andesite
- ▨ Pumice, at three foot depth
- ▨ Glacial ice sheets at peak

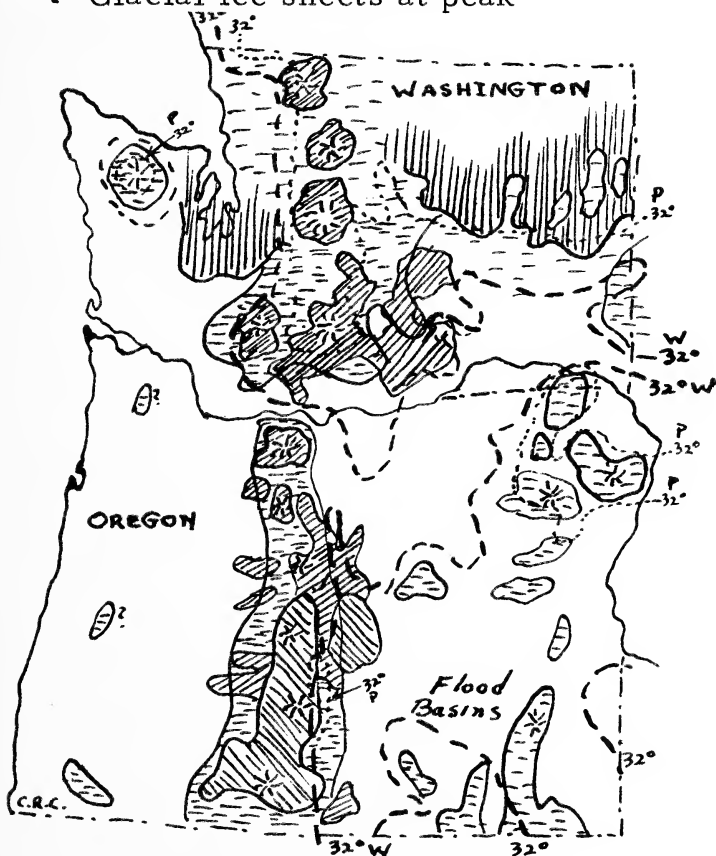


Fig. 6. Oregon-Washington Pleistocene Events.

species trapped between, and efficiently isolated, would probably, with time, subspeciate. This might prove to be the case with the present Cascadian *Euphydryas editha lawrenci* and *colonia*.

For comparison, the present 32°F. January maximum line has been drawn on the map with the possible 32° January maximum for Wisconsin peak, based on a 5° drop (Brooks) in average temperature. Present arctic-alpine limits (Bailey) have been included to compare with an assumed drop of 2,500 feet (Brooks) in the permanent snowline. This shows a large proportion of Oregon to be available to arctic butterfly fauna, but little is seen at the present in the state, though California has a relatively rich fauna. *Lycaena phlaes*, noted in California probably migrated along an arctic-alpine link from the Rocky Mts. across Utah and Idaho, into eastern Oregon and northern Nevada, and down the California Sierras, to be isolated during postglacial warming.

The student of Pleistocene climatology faces an apparent lack of data due to clues of a geological nature being few and far between. Students with a broad knowledge of many unrelated fields are required to sort the minimal data and draw conclusions. The following is a brief summary of some of the methods used to extract climatic data from ancient sources.

Varves. The ancient shores of lakes varied with the seasonal rainfall, with deposits of silt being left with each Spring flooding. Present varve records in Europe extend back some 13,700 years, giving precipitation estimates based on the thickness of the annual varves.

Micropaleontology. The study of fossilized microscopic organisms yields estimates of ocean temperatures for the species at the time of deposit. In the Atlantic Ocean cores have been taken, revealing detritus left by the oceanic ice, and various fossilized organisms, that are correlated with glacial advances, yielding considerable data concerning Pleistocene climates.

Pollen analysis. The comparison of pollen grains extracted from peat bogs with present surviving species gives an index of plant succession, and from knowledge of present species another climatic index. Fossilized floral and faunal remains offer the same index.

Tree rings. The analysis of tree rings has given us a climatic record extending back some 3,000 years or so in North America. It is possible that at some future date this method of analysis will overlap fossilized tree species, and the limit will be extended far into the Pleistocene. Comparison of rings of fossil species with

modern counterparts will yield approximate precipitation values for the period of growth.

Radioisotopes. There is an ever increasing use of radioisotopes in measuring of past events—the carbon 14 of organic substances and the radioactive fluorine of igneous rocks often can be used as prehistoric signposts from which climate may be indirectly established. The increasing dependency on obtained dates from these methods indicates a trend that may eventually replace conventional geological dating procedures.

The problem of the interested collector then, is one of locating published clues for the region of interest, and developing his own individual analysis for the species of interest. Where butterflies are concerned, geological events may prevent the spread of a localized species, and a familiarization with geological events in the area of interest becomes equally necessary with climatic data.

AUTOMATION

There at present is a “landslide” trend in the utilization of automated data processing equipment in all fields of research and endeavor. With greatly increased computer storage facilities, as on tape, it falls within economic and practical limits to store voluminous amounts of climatic data to be automatically compared and correlated with butterfly localities.

Even with, presently common, automated tabulating equipment a “master deck” of pre-punched climatic cards can be automatically compared with distributional cards, though a more time consuming process.

As automated equipment is dependent on standardization of procedures, it is suggested that the collector add notations of latitude and longitude to his collecting data, either in file or on specimens. With this data, it is a simple matter to collate large masses of of distributional data with climatic data on a grandiose scale, and we have but to peek towards the near future to see utilization of automated equipment and procedures in the study of Lepidoptera on a broad scale.

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THE GENUS *PANOQUINA* OCCURRING IN TEXAS

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THE PURPOSE OF THIS PAPER is to clarify at least in part the occurrence and distribution of members of the genus *Panoquina* in Texas.

Panoquina hecebolus (Scud.) has been known for several years to occur in Texas. Specimens are in certain collections in the United States. However, these records do not appear to have been formally published. Evans (1955) lists no specimens from the United States. *P. hecebolus* is not listed in McDunnough (1938). Klots (1951) discusses *P. hecebolus* and figures it in halftone on Plate 39, figure 6. Dos Passos (1964) does not include *P. hecebolus* in his list. He states (*in litt.*) that he knows of no authentic published records from the United States. Kendall and Freeman (1963) list *hecebolus* in a tentative list which is a forerunner of a forthcoming definitive Texas list.

Three species of *Panoquina*, namely *hecebolus* (Scud.), *ocola* (Edw.) and *sylvicola* (H.-S.), seem to have been confused with one another in our fauna. These species are not difficult to separate if one has at hand specimens of all three. All occur in southern Texas and may be taken on the same day or even flying together, along the Rio Grande at such localities as the Santa Ana Wildlife Refuge in Hidalgo County.

P. sylvicola has the outer margin of the primaries indented, so that the forewing is very narrow and pointed. There is a long cell spot on the upper surface of the forewing. The under surface of the hind wing bears a nearly straight line of small separate pale bluish white spots, usually six in number. In nature *sylvicola* sits with wings folded very far back, and looks very long and narrow at rest. The macular band is conspicuous. The entire insect has a submetallic sheen lacking in *P. ocola* and *P. hecebolus*.

Both *P. ocola* and *hecebolus* have the forewing less pointed and in nature appear less long and narrow when perched. Both appear dark brown or blackish with little or no sheen. *P. hecebolus* has a small but distinct cell spot in the forewing. This spot is lacking in *ocola*. *Hecebolus* is usually somewhat darker, especially on the under side of the hind wing.

Five species of *Panoquina* occur in Texas. The sixth species recorded from the United States, *panoquin* (Scud.), is so far not known to occur there.

The following records are from the collections of Roy Kendall, San Antonio, Texas, H. A. Freeman, Garland Texas, and the author.

Panoquina panoquinoides (Skin.)

CAMERON COUNTY—Texas Hwy. 4, 4 miles west of Boca Chica, 19.X.63, 9 ♂♂, leg. Kendall and Tilden, new county record; 20.X.63, series, leg. Tilden; 26.X.63, common, leg. Tilden 29.X.63, 1 ♂, leg. Tilden; 12.XI.63, 1 ♀, leg. Tilden; Port Isabel, 24.X.63, 1 ♂, 2 ♀, worn, leg. Tilden, Nueces County—Mustang Island, at Old Cemetery, 21.X.62, 13 ♂♂, 4 ♀♀, leg. Kendall (new county record); 24.XI.62, 30 ♂♂, 1 ♀ and 6:VII.63, 5 ♂♂, all leg. Kendall; 15.X.63, 5 ♂♂, 1 ♀, leg. Tilden. SAN PATRICIO COUNTY—Welder Wildlife Refuge, 3.XI.63, 1 ♂, leg. Tilden (new record for the refuge and for the county).

Panoquina ocola (Edw.)

BEXAR COUNTY—San Antonio, 7.VIII.57, 1; 8.IX.57, 2; 10.IX.57, 1; 14.IX.57, 2; 15.IX.57, 1; all leg. Kendall, in his own yard. Curiously absent since. He suggests city expansion. HIDALGO COUNTY—Pharr, 7.X.44, 1 ♀; 22.X.44, 1 ♂; 10.X.45, 1 ♂; 3.X.46, 1 ♀; 9.X.46, 1 ♀; 12.X.46, 1 ♂; 3.XI.46, 1 ♀, all leg. Freeman; Santa Ana Wildlife Refuge, 11.XI.63, 1 ♂, leg. Tilden. SAN PATRICIO COUNTY—Sinton, 24.XI.61, 2, leg. Kendall; Welder Wildlife Refuge, 25.XI.61, 4, leg. Kendall; 3.XI.62, 1 ♂, leg. Tilden.

Panoquina hecebolus (Scud.)

CAMERON COUNTY—Palm Grove, 12.XI.63, 3 ♂♂, 1 ♀, leg. Tilden; Villa Nueva, 25.X.63, 1 ♂, leg. Tilden. HIDALGO COUNTY—Hidalgo, 2 miles north, 31.X.63, 1 ♂, 1 ♀, leg. Tilden; Pharr, 15.X.44, 1 ♀; 16.X.44, 1 ♀; 11.XI.44, 1 ♀; 12.XI.44, 1 ♂; 11.XI.45, 2 ♂♂; 1.X.46, 1 ♂; 9.XI.46, 1 ♂; 14.XI.46, 5 ♂♂, 3 ♀♀, all leg. Freeman; Santa Ana Wildlife Refuge, 31.X.63, 1 ♂; 11.XI.63, common, series taken, all leg. Tilden.

Panoquina sylvicola (H.-S.)

HIDALGO COUNTY—Pharr, 16.IX.44, 1 ♂; 23.IX.44, 1 ♂; 14.X.44, 1 ♂; 15.X.44, 1 ♂; 21.X.45, 8 ♂♂, 3 ♀♀; 12.X.46, 1 ♀, all leg. Freeman. Santa Ana Wildlife Refuge, 11 ♂♂, 2 ♀♀; leg. Tilden.

Panoquina fusina evansi (Freeman)

CAMERON COUNTY—Brownsville, 13.XI.63, 1 ♂, leg. Tilden (new county record).

As far as can be found, this is the first specimen of this species to be taken in Texas since Freeman captured the types at Pharr, Hidalgo County, in 1944. Although Evans (1955) lists *evansi* Freeman as a subspecies of *fusina* Hewitson and is followed in this by dos Passos (1964), Freeman considers *evansi* a distinct species rather than a subspecies of *fusina* (personal communication).

It will be seen that *Panoquina* spp. in Texas are concentrated in the southeastern part of the state. *P. panoquinoides* is restricted to the coastal plains, often in open grasslands and the edges of salt marshes. The other species tend to occur in the more lush areas such as river bottoms, groves and the edges of resacas. *P. evansi* (Freeman) is very much larger than the other species and is very scarce. Apparently only three specimens are known from Texas. The remaining three species — *ocola*, *hecebolus* and *sylvicola* — are most likely to be encountered in the lower Rio Grande Valley, where all may occur together. All five species are strongly attracted to flowers.

**KEY TO THE SPECIES AND SUBSPECIES OF PANOQUINA
OCCURRING IN THE UNITED STATES**

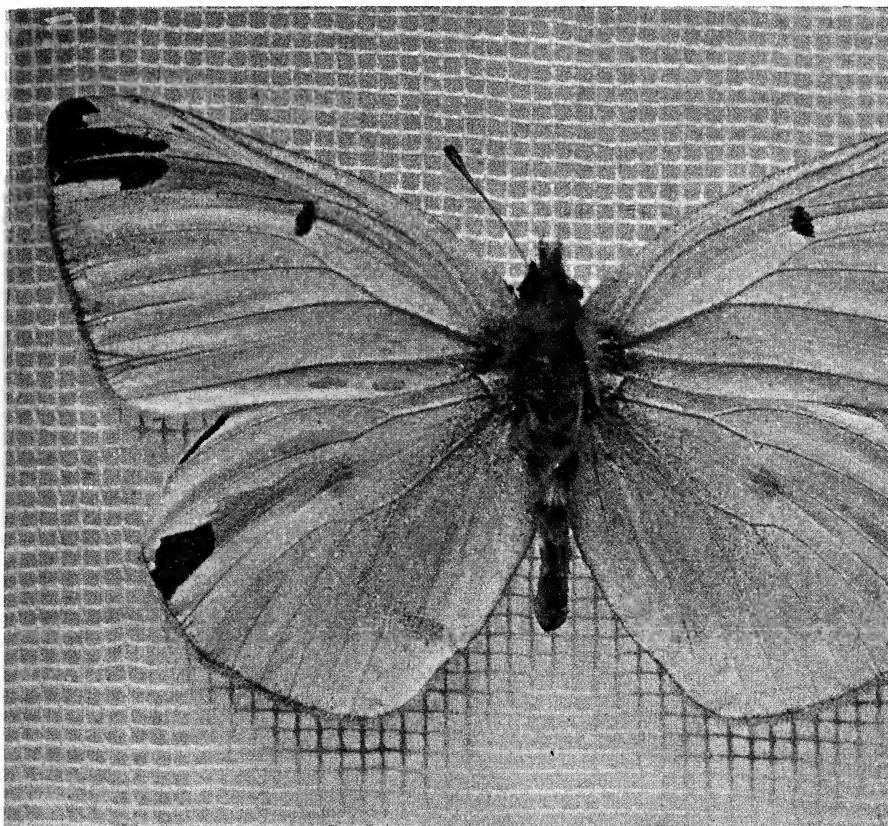
- | | | |
|---------|--|-----------------|
| 1a. | Size large, forewing more than 22 mm; spots of upper surface yellowish; under surface of hindwing with lavender iridescence, and with a broad iridescent bluish-white band | <i>evansi</i> |
| 1b. | Size smaller, forewing 18 mm or less; spotting of upper surface hyaline, white or ivory; iridescence reduced or absent; macular band of under surface of hindwing much reduced, of small separate spots, or absent | 2 |
| 2a(1b). | Forewing 12-15 mm; veins of under surface lighter than background; macular band when well-developed, not straight | 3 |
| 2b. | Forewing 17 mm or more; under surface with veins concolorous with ground color, or nearly so; macular band if present, straight | 5 |
| 3a(2a). | Under surface of hind wings with two (at times only one) pale dashes parallel to the veins; Florida to New Jersey; not known to occur in Texas | <i>panoquin</i> |
| 3b. | Under surface of hind wings with a curved median band of small light spots | 4 |

- 4a(3b). Median band of lower surface of secondaries broken in the middle; spots of upper surface yellowish, often much reduced; size smaller, forewing 12-14 mm; Florida and Texas*panoquinoides*
- 4b. Median band of hind wing complete; spots of upper surface ivory to white, well-developed ;size larger, forewing 13-16 mm; confined to California and Baja California*panoquinoides errans*
- 5a(2b). Forewing cell with pale spot 6
- 5b. Forewing cell without pale spot*ocola*
- 6a(5a). Vestiture of thorax and sometimes of under wing surface, slightly iridescent; under surface of secondaries with a straight band of 5-6 small powdery bluish-white spots.....*sylvicola*
- 6b. Vestiture of thorax not iridescent; under surface of secondaries immaculate or nearly so, the band either obsolete or at most very faintly indicated, and then not bluish-white nor the spots separated*hecebolus*

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A *COLIAS CHRISTINA* GYNANDROMORPH

Although gynandromorphs are not common in insects, they are not so rare that an occasional example does not show up in collections. They are probably more common than is generally realized. When the insect involved is a sexually dimorphic butterfly and when the tissues involved are differentially colored wings, the gynandromorph is quite obvious.

The specimen pictured is largely a female *Colias christina* with patches of male tissue. The female normally is all white except for the discal cell spots. The male is normally yellow and orange with a solid black border band on both wings (see cover illustration). This particular specimen from the Canadian National collection at Ottawa shows four patches of male tissue on an otherwise female wing pattern, one patch extending all the way from the body to the border.

William Hovanitz

COLIAS CHRISTINA — ALEXANDRA INTERGRADATION

(Cover Illustration)

Hybridization between species of *Colias* has been shown to be a not uncommon phenomenon. In the case illustrated by the eight specimens on the cover photograph, the variation shown, ranging from full yellow at the upper left to the bright orange at the lower right, is from a population of *Colias christina—alexandra* complex from the Waterton Lakes area of Alberta, Canada. The specimens are from the Canadian National Collections in Ottawa, Ontario, Canada.

Populations of these *Colias* from the north and east of this locality are generally orange or orange-yellow in the male. Populations to the south and west of this location are generally yellow. The zone of intergradation of these *Colias* follows fairly generally the eastern escarpment of the Rocky mountains from the Yukon Territory to Montana with the orange to the north and east and the yellow to the south and west. Populations along this line consist of individuals of both color types and all intermediates.

A more complete discussion of the variation, and the interrelationships of North American *Colias* will be presented in the near future.

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THE MOTHS (MACROHETEROCERA) of a
CHAPARRAL PLANT ASSOCIATION
in the SANTA MONICA MOUNTAINS
of SOUTHERN CALIFORNIA

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THIS ANNOTATED LIST of moths presents the complete results of 5 years of intensive collecting (1953-1957), and about 5 years of sporadic collecting (1948-1952), during 20 years of residence (1938-1958), in one locality in the Santa Monica Mountains of coastal Southern California. Without exception, all the nocturnal moths were collected at this specific address: 9601 Oak Pass Rd., 4.6 miles north of Beverly Hills, Los Angeles County, California, in the eastern Santa Monica Mountains, on a ridge at 1,100 feet elevation. (Mileage from Beverly Hills is measured from Sunset Blvd. at Benedict Canyon Dr.). Most elevations in the area are under 1,000 feet, although a few ridges reach approximately 1,200 feet.

DESCRIPTION OF THE ENVIRONMENT

Vegetation: The vegetation in the locality was, at the time of this study, relatively undisturbed; however, the area has been undergoing drastic change since about 1955, due to increase in population and residential expansion. Extensive subdivisions are totally destroying the native vegetation in many places. It would, therefore, be of value to describe the native vegetation as it originally was, listing important plants alphabetically. (The two lists that follow are not complete, but they include the prominent plants in the area, as well as a number of the less abundant species).

Most of the ABUNDANT plants at 9601 Oak Pass Rd., or within one mile: *Adenostoma fasciculatum*, *Artemisia californica*, *A. douglassiana*, *Asclepias eriocarpa*, *Brassica geniculata*, *B. nigra*,

Brickellia californica, *Brodiaea* sp., *Ceanothus megacarpus*, *C. spinosus*, *Centaurea solstitialis*, *Cercocarpus betuloides*, *Chlorogalum pomeridianum*, *Collinsia* sp., *Cordylanthus filifolius*, *Corethrogyne filaginifolia*, *Cuscuta subinclusa* (on *Ceanothus spinosus*, *Rhus laurina*, etc.), *Delphinium cardinale*, *Elymus condensatus*, *Encelia californica*, *Eriogonum fasciculatum*, *Eriophyllum confertiflorum*, *Erodium* spp., *Galium angustifolium*, *G. nuttallii*, 3 *Gnaphalium* spp., *Godetia* (*Clarkia*) sp., *Haplopappus squarrosus*, *Heteromeles* (*Photinia*) *arbutifolia*, *Heterotheca grandiflora*, *Juglans californica*, *Lathyrus laetiflorus* ssp., *barbarae*, *Lonicera subspicata* var. *johnstonii*, *Lotus scoparius*, *Lupinus succulentus*, *Malacothrix saxatilis* (var.?), *Malva parviflora*, *Marah macrocarpus*, *Marrubium vulgare*, *Medicago hispida*, *Melilotus indicus*, *Mimulus longiflorus*, *Montia perfoliata*, *Nicotiana glauca*, *Penstemon cordifolius*, *Perezia microcephala*, *Phoradendron flavescens* (on *Juglans*), *Prunus ilicifolia*, *Quercus agrifolia*, *Q. dumosa*, *Rafinesquia californica*, *Rhamnus crocea* ssp. *ilicifolia*, *Rhus diversiloba*, *R. laurina*, *R. ovata*, *R. trilobata* var. *malacophylla*, *Ribes malvaceum*, *R. speciosum*, *Salvia apiana*, *S. mellifera*, *S. spathacea*, *Sambucus mexicana*, *Sanicula* sp., *Solanum douglasii*, *S. xantii* var. *intermedium*, *Stephanomeria exigua*, *S. virgata*, *Symphoricarpos mollis*, *Venegasia carpesioides*, *Verbena* sp., *Yucca whipplei* ssp. *intermedia*, and *Zauschneria californica* ssp. *angustifolia*.

Other plants (but LESS ABUNDANT) within the same area: *Anagallis arvensis*, *Arctostaphylos glandulosa* (on Peavine Ridge), *Artemisia dracunculus*, *Astragalus* sp., *Baccharis pilularis*, *B. viminea*, *Brodiaea* sp. (yellow flower), *Capsella bursa-pastoris*, *Chenopodium*, *Chorizanthe staticoides*, *Cirsium*, *Convolvulus*, *Cryptantha*, *Dendromecon rigida*, *Dudleya lanceolata*, *Emmenanthe penduliflora*, *Eremocarpus setigerus*, *Eriogonum elongatum*, annual *Euphorbia* spp., *Foeniculum vulgare*, *Fritillaria biflora*, annual *Gilia* sp. (?), *Grindelia robusta*, *Haplopappus* sp., *Helianthemum scoparium* (on Peavine Ridge), *Hemizonia ramosissima*, *Hesperocnide tenella*, *Leptodactylon californicum*, perennial *Lupinus* sp. and several annual *Lupinus*, *Malacothamnus fasciculatus* (var.), *Mirabilis laevis*, *Nemophila menziesii*, *Orthocarpus* sp., *Oxalis* sp., *Paeonia californica*, *Penstemon spectabilis*, *Phacelia minor*, *Pholistoma auritum*, *Potentilla* sp., *Rhamnus californica*, *Rhus integrifolia*, *Scrophularia californica*, *Silene laciniata* ssp. *major*, *Sisyrinchium bellum*, *Stachys* sp., *Trichostema lanatum*, and *Urtica holosericea*.

(NOTE: Names of plants follow Munz and Keck, 1959).

The vegetation immediately surrounding the collecting site, and for one or more miles in every direction, was mostly native and undisturbed (except along the roadside, and on a few cleared lots). In the garden, nearby, were some ornamental plants such as *Lantana* (2 spp.), wisteria, and Lombardy poplar, etc., along with many natives such as *Quercus agrifolia*, *Ceanothus spinosus*, *Rhus laurina*, and *Rhamnus crocea*, etc. Undisturbed native formations of Chaparral, Coastal Sage Scrub, and Southern Oak Woodland (after Munz and Keck, 1959), grew right up to the borders of the garden on all sides; the elements of these three plant communities were growing more-or-less intermixed throughout the area. (Figs. 1,2).

In this immediate locality, there was a notable lack of any native coniferous plants, or any members of the Garryaceae. Manzanita (*Arctostaphylos*) was very rare. *Salix* and *Platanus racemosa* were abundant in canyons, but more than one mile away. Several grasses were common, although only one prominent species is listed above. Also, there were a number of different ferns, mosses, and various lower plants (fungi, lichens, etc.).

Climate: This locality is under the influence of a *Mediterranean climate*. In general, it could be said that the rainy season extends from approximately October (or later) through April. Annual rainfall is usually between 10 and 20 inches. The temperature rarely drops below 32°F., and is usually above 40°F. (as a minimum). Winter daytime highs are usually above 50°F., and often well above 60°F. Rains are sporadic, but may last for several days and nights, during heavy storms. Snow almost never falls (i.e.—once or twice in 15 years). The peak of plant growth occurs between March and June, although many annuals start growth with the early rain of October or November. Most of the plants bloom between April and early June. The rainless season extends from April or May to October (or later); no rain whatsoever falls during the period of summer drought, although an occasional early rain may come in September (very unusual). By September or October, prior to the first rain, the vegetation is at its driest. The hottest weather comes in July, August, and September. Summer temperatures are often over 80°F., but rarely above 100°F. (Usual daytime highs are between 70° - 90°F.). There is usually a short hot spell in October (one week or less), and again in January or



Fig. 1. Photograph taken in 1938, from upper Oak Pass Rd. in the Santa Monica Mountains, looking west toward the house at 9601 (where this survey took place). A Chaparral association clothes the slope in the foreground. Large trees of *Quercus agrifolia* dominate around (and below) the house, and in the ravines. The lighter patches in the vegetation represent mostly Coastal Sage Scrub species, with some admixture of Chaparral plants. In the area are several open slopes, covered with grass and mustard (*Brassica nigra*), where *Juglans californica* grows as a dominant tree. The house is at an elevation of about 1100 feet, and is 9 miles inland from the Pacific Ocean. Upper Benedict Canyon Dr. is visible beyond the house.

February. Foggy weather is frequent from April through October; this increases the humidity during the dry season. Fog often comes in from the ocean around 5 P.M. (or later), and may leave by 11 A.M. (or earlier) the next morning. In May and June, overcast or foggy days are particularly frequent, although the afternoons are often sunny.

By late in the dry season, nearly all the woody plants are dormant. However, *Zauschneria californica* and *Haplopappus squarrosus* are among the comparatively few plants that bloom from late Aug. to Oct., prior to the first rains. Earlier in the dry season (July-Aug.), the following few species are the dominant plants in bloom: *Cuscuta subinclusa*, *Delphinium cardinale*, *Eriogonum fasciculatum*, *Hemizonia ramosissima*, *Heterotheca grandiflora*, *Photinia arbutifolia*, *Rafinesquia californica*, *Rhus laurina*, and *Sambucus mexicana*.

Smog was never seen in this locality (i.e.—Oak Pass Rd. and vicinity) prior to about 1950.

METHODS OF COLLECTING

Except for the diurnal species, all the moths were collected in *one location*, at the N.E. corner of the house. Two types of lights were used: (1) a 150 or 300-watt Westinghouse clear blue daylight bulb (incandescent) was used until May, 1956; (2) after May, 1956, two 15-watt black lights (ultraviolet tubes—F15T8/BL, without filters) were used exclusively. The lights were hung in front of a white sheet, which was tacked to a wall of the house, on a porch about 8 feet above the ground, facing a dense growth of chaparral mingled with *Quercus agrifolia*. The lights were turned on nearly every night, in all types of weather, and all months of the year were equally sampled throughout the survey. No traps were used.

INTRODUCTION TO THE LIST

The families follow the arrangement in Part I of the *Check List of Lepidoptera of Canada and the United States of America* by J. McDunnough (1938). The genera and species are arranged *alphabetically*, within each family, for ease of locating the species in this list. (The McDunnough numbers are included, however, immediately following the species' names). If a question-mark precedes a specific name, this indicates that there is some doubt as to the correct identity of the species; where there is considerable doubt, no specific name is included. Occasional subspecific names are included. In most cases, no



Fig. 2. A view from below the porch where all collecting took place. Two ultraviolet lights are in position on the wall. This porch overlooked the slope N. E. of the house, which is visible in Fig. 1. In the foreground is *Elymus* (giant rye), with *Heteromeles arbutifolia* (toyon) on the right.

mention is made of color forms. For species illustrated on one of the five plates, a small circle (°) precedes the generic name at the left margin of the page.

Following the number (1), the first item given is the *Flight-period* of the adult; this covers any extreme records. Wherever a hyphen is used between separated months, this indicates that I have records for all intervening months as well; otherwise, the months are separated by semi-colons, where gaps occur in the flight-period. *Months underlined* indicate times when the moth is present in its greatest abundance in the locality being discussed. Example: "July-Oct." indicates that the moth is at its peak of abundance during July, Aug. Sept., and Oct., but "July-Oct." indicates that, although the moth has been recorded for July, Aug., Sept., and Oct., it is at its peak only during July and Oct., but not from July through October. "Early" (preceding a month) indicates the period from the first through the 10th of the month; "mid" indicates the period from the 11th through the 20th; "late" indicates the period from the 21st through the 31st. The next item given is the word "diurnal", in cases where it applies. (Otherwise, the species is nocturnal in its flight, and comes to light). The last item after (1) is the *abundance-rating* which I have given to the species, based on its occurrence in the specific locality where this survey was conducted, between about 1948 and 1958. The relative abundance of the moth is expressed by the letter A, B, or C, as follows:

A = abundant; B+, B, B- = moderate abundance (neither notably common or rare); C = scarce (6 or fewer records during the entire survey), C₁ = only *one* record during the entire survey, "B+" (= approaching "A" and "-" (= approaching "C") are intended to show an inclination either *towards* abundance or scarcity, but the species is still better placed within the "B" category.

Following (2), some known *foodplants* are listed; many of these are from my personal records (primarily in the Santa Monica Mountains). If the foodplants are not my records, the information was obtained from one of the following sources: (a) Mr. Christopher Henne (plant followed by "C.H." in parentheses); (b) the card file of Dr. John A. Comstock (J.C.); (c) Crumb (1956) (S.C.). If the foodplants are followed by "etc.", this indicates that other plants (not listed) are also known to be acceptable. These foodplant-listings are not by any means

complete for every moth, nor are they intended to summarize the literature.

Following the number (3), miscellaneous remarks are indicated, which may refer to the adult or to the early stages (*i.e.*—variability; peculiarities in behavior; short notes on the early stages; anything distinctive and worth noting). For many species, (2) and/or (3) may not be included in this list.

MISCELLANEOUS REMARKS

The abundance-ratings given for each species should be of interest in future years, as the area becomes more and more disturbed by man, and the native vegetation is destroyed. Changes in abundance are bound to occur, and some changes in species-composition are also likely in the future. A noticeable change in the vegetation, which has become very evident during the past decade, is the death of most of the oaks (*Quercus agrifolia*) throughout the area. Coast live oaks were formerly abundant, and dominant in canyons (and on many hillsides), where they are now dying or already dead. The trees were in excellent condition up to approximately 1948. (See the photograph taken in 1938, showing the abundance of healthy oaks that once surrounded the house at 9601 Oak Pass Road). Increasing smog may be one of the factors responsible for the death of the oaks, and it may be having an effect on other vegetation in the area.

The specimens collected during this survey are chiefly in the author's collection, and in the collection of the Los Angeles County Museum. Some are in the possession of W. R. Bauer and J. S. Buckett, Dr. J. G. Franclemont, Dr. Frederick H. Rindge, and Carl W. Kirkwood.

The following list gives the total numbers of species collected per family, during this survey of a single locality:

1. Sphingidae	6	8. Noctuidae	160
2. Saturniidae	2	9. Dioptidae	1
3. Amatidae	1	10. Notodontidae	2
4. Nolidae	2	11. Liparidae	1
5. Lithosiidae	1	12. Lasiocampidae	3
6. Arctiidae	6	13. Geometridae	92
7. Agaristidae	1	TOTAL	278

Compared with many other regions of the U.S.A., the Sphingidae, Arctiidae, and Notodontidae are very poorly represented throughout coastal Southern California.

Complete coverage of all the "macro-moths" in the eastern Santa Monica Mountains was not possible, as all collecting was restricted to a single location. Moths normally feeding on willows, or other canyon vegetation, may have been missed entirely, or they may be rated as scarce in this list. (The nearest typical canyon habitats were over one mile away). However, nearly all of the moths in an area are usually encountered when one collects in a single locality, provided that the locality chosen has vegetation widely-representative of the area as a whole, and provided that the locality is consistently well-collected for five (or more) *consecutive* years; by collecting over a period of several consecutive years, those species that fluctuate greatly in numbers will usually be encountered at least once, and sometimes more than once. Moth-collecting should also sample the hours between midnight and 4 A.M., for every month of the year. There are some moths, in nearly every family, that almost never come to lights before midnight, and a few of these species do not reach their "peak" of activity until the period of 2 to 4 in the morning.

As of July 1964, the species listed below have been preserved in the author's collection of preserved early stages of Lepidoptera, which was started in May 1960. They are catalogued under the code-numbers given in parentheses. (This letter-number combination refers to the preserved early stages, as well as to corresponding pinned adults, and to color and behavioral descriptions kept in notebooks). SPHINGIDAE: *Celerio lineata* (Sp. 7), *Smerinthus cerisyi* (Sp. 9), *Sphinx perelegans* (Sp. 12); SATURNIIDAE: *Platysamia euryalus* (St. *), *Telea polyphemus* (St. 2); NOLIDAE: *Celama minna* (Nl. 1); ARCTIIDAE: *Apantesis ornata* (Ar. 25), *A. proxima* (Ar. 5), *Arachnis picta picta* (Ar. 20), *Estigmene acraea* (Ar. 2), *Hemihyalea edwardsi* (Ar. 3), *Maenas vestalis* (Ar. 21); NOCTUIDAE: *Acerra normalis* (N. 41), *Behrensia conchiformis* (N. 43), *Catabena lineolata* (N. 11), *Catocala aholibah* (N. 84), *C. verrilliana* (N. 70), *Cissusa indescrcta* (N. 72), *Cucullia* ? *laetifica* (N. 90), *Dargida procincta* (N. 47), *Heliothis phloxiphaga* (N. 9), *H. zea* (N. 4), *Laphygma exigua* (N. 78), *Miodera stigmata* (N. 37), *Orthosia ferrigera* (N. 69), *Pleroma conserta* (N. 39), *Zosteropoda hirtipes* (N. 58), *Zotheca tranquilla* (N. 36); DIOPTIDAE: *Phyrganidia californica* (Di. 1); LIPARIDAE: *Hemero-campa* ? *gulosa* (Lp. 6); GEOMETRIDAE: *Chlorochlamys* ? *hesperia* (G.20), *Chlorosea* ? *gracearia* (G. 70), *Cochisea sin-*

uaria (G. 53), *Dichorda illustraria* (G. 22), *Epirrhoe plebeculata* (G. 30), *Eupithecia nevadata* (G. 34), *Sabulodes caberata* (G. 23), *Sicya snoviaria* (G. 18), *Stamnodes ? coenonymphata* (G. 31), *Sterrhia bonifata* (G. 10), *Synchlora liquoraria* (G. 19), *Triphosa californiata* (G. 52), *Zenophleps lignicolorata* (G. 54).

In most cases these preserved immatures are from localities other than the Santa Monica Mountains. For fifteen of the above species, the complete life histories (all stages and all larval instars) are represented, and in nearly all cases the last instar larva is preserved.

All personal foodplant records given in this paper are backed by reared, identified moths, but the larvae were preserved for only a few of the species, unfortunately.

COMMENTS ON COLLECTING

IN THE COASTAL CHAPARRAL OF SOUTHERN CALIFORNIA

Nights of heavy fog and mild temperatures, particularly from late March through June, and during October - November, are the best times for moth collecting in the coastal chaparral areas. During these months, the greatest numbers of species are on the wing. (Mild, foggy nights seem to bring out hosts of moths, at almost any time of the year).

As most of the dominant plants under the influence of a Mediterranean climate have tough, leathery leaves, larvae are rarely present on such plants for more than three or four weeks, during the time when the plants are in new-leaf, or when they are in bloom. The peak season for most larvae on these sclerophyllous plants is between March and June. For example, most of the larvae that feed on *Quercus agrifolia* are present only during a short period in late March or April, when the new leaves are still soft. (A notable exception to this particular case is the larva of *Hemihyalea edwardsi*).

Beating chaparral vegetation from March to late June will produce a great variety of larvae. Among the most productive woody plants in the chaparral association, at this season, are: *Adenostoma fasciculatum*,* *Arctostaphylos* spp.*, *Ceanothus* spp.*, *Cercocarpus betuloides*,* *Eriogonum fasciculatum*, *Heteromeles arbutifolia*, *Lonicera subspicata*, *Penstemon cordifolius*, *Prunus ilicifolia*, *Quercus* spp.*, *Rhamnus crocea*, *Rhus laurina*, *Rhus trilobata*, *Ribes speciosum*, and *Sambucus mexicana*.*

*The starred plants support numerous species of moth larvae in the spring; *Ceanothus*, *Cercocarpus*, and *Quercus* are perhaps the top three plant genera in this locality, as to the numbers of different larvae feeding upon them.

For best results, it is necessary to beat (or search) the plants at night, as well as in the daytime. Some larvae are strictly nocturnal feeders, and cannot be collected by beating in the daytime, when they are hiding on the lower stems, or in litter beneath the plants.

Adenostoma fasciculatum supports the greatest number of larvae when it is in bloom; even at lower elevations this is not until late May or June, when most of the other sclerophyllous plants are slowing down in growth, and their leaves are becoming tough. Other plants in the chaparral association, which continue to grow well into the summer, and do not have sclerophyllous leaves, support various larvae even during the dry summer; the same may be said of some sclerophyllous species which continue to grow a little during the summer, such as *Eriogonum fasciculatum*, *Lonicera subspicata*, and a few others. *Ceanothus spinosus* remains suitable for larval feeding all summer, but its leaves are quite thin even when matured. *Rhus laurina* and *R. trilobata* also appear to remain suitable for larval feeding all summer, and this is particularly true of foliage that is partially in the shade. (See *Paectes declinata*, in the list).

For collectors who desire to collect in the eastern Santa Monica Mountains, under conditions similar to those described in this paper, with the chance of finding these same species on the wing at the same times of the year, there still remains one extensive undisturbed locality within two miles of the 9601 Oak Pass location. It is presently (June, 1964) in the same virgin state as it was in 1938 or earlier. This rich sanctuary of undisturbed native vegetation (Higgins Canyon) is between 2.2 and 3.5 miles north of Beverly Hills, north of Sunset Blvd. on N. Beverly Drive; it is bounded on the west by Summitridge Dr., on the north by Mulholland Dr., and on the east by Franklin Canyon Dr.; Marion Way fire-road crosses the heart of this area, which is locked off by fire-gates. The area is easily accessible by a half mile walk beyond the fire-gate, at the upper end of N. Beverly Drive (2.2 mi. N. of Sunset Blvd.). Franklin Canyon (right turn off N. Beverly Dr., above Sunset) is still relatively undisturbed, and also has a good representation of the plants listed in this paper.

THE ANNOTATED LIST OF SPECIES

1. Family SPHINGIDAE

Celerio lineata Fabr. (799) (1) Mar. - Sept.; diurnal and nocturnal; B (2) *Godetia* (=Clarkia), *Zauschneria californica*, etc. (3) The larvae are primarily of the black phase in this locality.

**Hemaris diffinis* Thetis Bdv. (770c) (1) Mar. - May - Aug.; diurnal only; A (2) *Lonicera subspicata* (3) The larvae, which are soft green, marked with purplish-brown on the underside and prolegs, are well-hidden as they cling to the undersides of stems of the foodplant; these stems are often tinged purplish on the upperside, where the sun strikes them. In feeding, the entire leaf is usually consumed, which further conceals evidence of the larva. The larva is quite inactive most of the time, but when it does crawl, it exhibits a peculiar and very characteristic, hesitant, "forward-inching" type of locomotion; this allows it to move inconspicuously along, without drawing much attention to itself. It is of interest to note that when the moth first emerges from the pupa, and up until the time it makes its first flight, its wings are fully-covered with large, loosely-attached, dull black scales. In the instant that it takes off on its very first flight, all these loose scales blow off in a cloud. The adult is a fast flier, active on sunny days only, and is easily alarmed. In the garden, where this survey was made, it came abundantly to ornamental *Lantana*.

Phlegethontius sexta Joh. (696) (1) July - Aug.; B- (2) *Nicotiana glauca*

Pholus achemon Dru. (773) (1) Late Aug.; C₁ (2) *Vitis* (J. C.)

Smerinthus cerisyi Kby. (740) (1) May - June; C (2) *Populus*, *Salix* (J. C.)

**Sphinx* ? *Perelegans* Hy. Edw. (724) (1) Apr. - May - Aug.; B+ (2) *Prunus ilicifolia*, *Cercarpus betuloides* (3) The last instar larva is whitish blue-green and has seven oblique white lateral stripes, each of which is anteriorly-edged by reddish-purple or violet. The skin is absolutely smooth (not granular). The head has a pair of prominent oval black spots at its apex; these are sometimes covered by the lavender cervical membrane when the larvae is at rest. The smooth caudal horn is light blue with a very faint lavender tinge at the base. In all instars the horn is minutely two-pointed at the tip. The brown pupa has a short (3/8") external tongue-case. The moth is characterized by its charcoal-black thorax, which is edged with pale gray at the sides.

II. Family SATURNIIDAE

Platysamia euryalus Bdv. (807) (1) Feb. - May; B (2) *Ceanothus spinosus*, *C. megacarpus*, *Rhamnus crocea*, etc.

Telea polyphemus Cram. (812) (1) May - June; Aug. - Oct.; C (2) *Quercus agrifolia*, etc.

III. Family AMATIDAE

**Tenucha brunnea* Stretch (881) (1) June - July; diurnal only; A (2) *Elymus condensatus*, St. Augustine grass, and other coarse grasses (3) The hairy larvae are easily located in clumps of *Elymus* during May. Much of the time, they rest on dead (tan) leaves, which blend well with the predominantly tan and pale gray of the larva. Evidence of feeding is noticeable on nearby green leaves. If touched, the larva will often literally snap into a curled posture, as it drops from the leaf. A distinctive feature of the larva is the rich tan (or golden brown) color of its shiny head. In this locality, it is the only larva (other than *Acronycta* spp.) that might be mistaken for an arctiid. Pupation occurs in an elongate cocoon of soft, web-like silk, into which the larval hairs are incorporated. The pupa is marked with blackish and reddish-brown (streaked pattern on wing cases), and is extremely shiny and smooth. The adult often rests upon the upper surface of a leaf (or in *Elymus* clumps), where it will sit in the sun, slowly waving its antennae. It visits flowers frequently; preferred are *Lantana* (ornamental), *Rhus laurina*, and *Photinia arbutifolia*. The flight is rather "heavy" and direct.

IV. Family NOLIDAE

**Celama minna* Butl. (891) (1) Jan. - Feb. - Mar. - May; A (2) *Ceanothus spinosus* (preferred), *C. megacarpus*, *Rhamnus crocea* (3) The small, hairy larvae are easily distinguished from lithosiids or arctiids, as they have only 4 pairs of prolegs; there are no prolegs on A₃. The usual dorsal ground color of the larva is rust-brown, with darker brown patches; a few larvae are tan or whitish, marked with brown. They are present on the foodplant in May and June.

**Sarbena minuscula eucalyptula* Dyar (897b) (1) Feb. - Mar.; A (2) Young leaves of *Quercus* (C. H.)

V. Family LITHOSIIDAE

**Cisthene dorsimacula* Dyar (951) (1) June; C (2) Lichens (J. C.)

VI. Family ARCTIIDAE

**Apantes ornata* Pack. (1039) (1) Late Apr. - early May; female diurnal; B (2) General feeding on low-growing plants (3) Males came to lights only after midnight, and primarily between 2 - 4 A.M. The form in this locality, although somewhat variable in color, is rather large, and the secondaries are usually pure yellow (sometimes reddish), marked with black. The lines on the primaries are bright pink; this fades in dried specimens.

APANTESIS PROXIMA Guer. (1045) (1) Late Mar. - June - Oct. - Nov.; A (2) General feeder on low growing plants; two specific records are *Nicotiana glauca* and *Brassica geniculata* (3) Unlike many other *Apantesis* larvae, the larvae of *A. proxima* are more inclined to hide by day, and are less prone to sunning themselves. Typical of *Apantesis* larvae, they will run with extreme rapidity if prodded from behind. The cocoon is slight, and no larval hairs are used in its construction; it is formed under leaf-litter or other debris, on the ground. The pupa is typical of many other *Apantesis* pupae in that it is covered with a glaucous bloom, and the discarded larval skin remains attached to the rear end; it is capable of slow abdominal movement. Both sexes of the adult come to light.

ARACHNIS PICTA Pack. (1082) (1) Late Sept. - Oct. - mid Nov.; A (2) General feeder on numerous herbaceous plants; some specific records are *Lotus scoparius*, *Brassica nigra*, *B. geniculata*, *Malva parviflora*, etc. (3) The young larvae feed and grow all winter and early spring, reaching last instar in Apr. or May. By June or early July, all feeding is finished and aestivation begins; this lasts until sometime in September. A cocoon of colorless, sticky, web-like silk is spun; no larval hairs are used in its construction. The dark pupa is incapable of visible abdominal movement. Adults appear soon after pupation (in 2 - 3 weeks). A melanic female was collected on October 9, 1956.

ESTIGMENE ACRAEA Dru. (1070) (1) June - Aug. - Sept.; C₁ (2) General feeder on numerous plants (3) A smokey phase occurs in the city, near the locality of this survey.

HEMIHYALEA EDWARDSII Pack. (974) (1) Late Sept. - Oct. - mid Nov.; A (2) *Quercus agrifolia*, and other oaks in other areas (3) A notable feature of the mature larva is its immense head, which is deep brown and glossy. The massive mandibles easily chew the toughest oak leaves. The larvae grow from November until the following August. They hide in crevices by day, and crawl up the trunk to feed after dark. Pupation takes place in Aug. - Sept., in a soft silk cocoon bristling with the larval hairs; this is usually in a crevice in the oak trunk. The bright, rich reddish-brown pupa is notably smooth and shiny, and the wing cases are (at first) translucent. It is not capable of abdominal movement.

MAENAS VESTALIS Pack. (1068) (1) Late Feb. - Apr. - mid May; A (2) General feeder on numerous plants; some specific records are wisteria, jasmine, *Lotus scoparius*, *Brassica geniculata*, *Marah macrocarpus*, *Nicotiana glauca*, *Juglans californica*, *Rhamnus crocea*, etc. (A preference is often shown for *Marah*, but it always dries up long before the larvae have reached last instar). (3) Larval growth is completed by Aug. or Sept., at which time an oval silken cocoon (filled with the larval hairs) is spun. The blackish pupa overwinters. It is not capable of abdominal movement.

VII. Family AGARISTIDAE

ALYPYA RIDINGSII Grt. (1117) (1) Mar. - mid Apr.; diurnal only; B - (2) *Oenothera*, *Codetia* (=Clarkia) (J. C.) (3) The adults usually fly along ridge-tops during the short flight period. They are rather hard to capture, and rarely alight. In this locality, they seem to prefer fire-breaks or open ridge-tops (Peavine Ridge) surrounded by chamise (*Adenostoma fasciculatum*), and other chaparral shrubs.

VIII. Family NOCTUIDAE

ABAGROTIS BARNESI Benj. (1594) (1) June - Oct.; B+ (2) *Salvia apiana*, in May-June (C. H.)

ABAGROTIS DENTICULATA McD. (1) June - Oct.; A

ABAGROTIS MIRABILIS Grt. (1586) (1) Late Sept.; C₁

ABAGROTIS sp. (new) (1) Mid May - Aug.; B -

ABAGROTIS TRIGONA Sm. (1589) (1) June - Oct.; B

***ACERRA NORMALIS** Grt. (1923) (1) Jan. - Feb. - Mar. - early Apr.; A (2) *Sambucus mexicana*, *Ribes*; *Salix* (S. C.), etc.

***ACONTIA CRETATA** G. and R. (3214) (1) June - July; B-

ACRONYCTA IMPLETA Wlk. (1201) (1) Early Aug.; C₁ (2) *Alnus*, *Salix*, *Quercus*, etc. (S. C.)

ACRONYCTA MARMORATA Sm. (1200) (1) Late Mar. - Apr.; C (2) *Quercus* (S. C.)

(3) Only melanic specimens were encountered.

***ACRONYCTA OTHELLO** Sm. (1213) (1) Mar. - July - Aug.; A (2) *Rhus laurina*, *Photinia arbutifolia*; *Salix* (J. C.)

ADELPHAGROTIS INDETERMINATA INNOTABILIS Grt. (1567a) (1) Late Aug. - mid Sept.; B (2) *Salix*, *Rubus*, etc. (S. C.)

***ADMETOVIS SIMILARIS** Barnes (1659) (1) Late Mar. - Apr. - May - early Aug.; B (2) *Sambucus mexicana*

AGROTIS YPSILON Rott. (1435) (1) Mar. - Oct. - Nov.; A (2) General feeder on many low-growing plants

AMATHES C-NIGRUM Linn. (1511) (1) Feb. - July - Oct. - Dec.; B- (2) General feeder

ANNAPHILA ? PSEUDOASTROLOGA Sala (1) Feb. - Mar.; diurnal only; B- (2) *Phacelia minor* (record of Frank Sala) (3) The foodplant of *Annaphila astrologa* B. and McD. (*Emmenanthe*) also grows in this locality.

ANOMOYNA INFIMATIS Grt. (1563 and 1563a) (1) Late Sept. - Oct. - Nov. - early Dec.; A

ASEPTIS ? BINOTATA Wlk. (2400) (1) Apr. - May - June - July; A (2) *Ribes malvaceum*, etc.

ASEPTIS sp. (near *binotata* Wlk. ?) (1) Late Mar. - Apr. - May; B (3) This moth perhaps belongs with the preceding species.

- ASEPTIS FUMOSA Grt. (2394) (1) Early June; C₁
 ASEPTIS PERFUMOSA Hamp. (2396) (1) Mar. - Apr. - May; A
 ASEPTIS SUSQUESA Sm. (2407) (1) Apr. - May; C (2) Artemisia californica (J. C.)
 AUTOGRAPHA BILOBA Steph. (3279) (1) Feb. - Oct.; B (2) Collinsia, and other
 herbaceous plants (3) Adults are occasionally active in the daytime.
 AUTOGRAPHA CALIFORNICA Speyer (3288) (1) Jan. - Feb. - Oct.; diurnal and
 nocturnal; A (2) Malacothrix, and numerous other herbaceous plants; abundant on Salvia leuco-
phylla, after a fire (C. H.), in Latigo Canyon (May, 1957).
 AUTOGRAPHA EGENA Gn. (3267) (1) Mid Oct.; C₁ (2) Lima bean leaves (S. C.)
 AUTOGRAPHA OLIVACEA Skin. (3294) (1) July; Nov.; C (2) Senecio grandiflora-
 ornamental plant from Mexico (C. H.); Mimulus cardinalis (C. H.)
 •BEHRENSIA CONCHIFORMIS Grt. (2264) (1) Dec. - Mar. - early Apr.; B+ (2)
Lonicera subspicata; Symphoricarpos, in Oregon (3) The slender gray-brown larva (with two
 small caudal points on Ag) can be located in April and May, by signs of its feeding on the vigorous
 new shoots of Lonicera clumps. Over a period of several nights, one or more larvae will continue
 to eat leaves from a single new shoot, until it is nearly stripped of its widely-spaced leaves. The
 larvae feed only after dark, and rest parallel to woody stems, deep within the tangle of branches,
 during the day. In general appearance, the larva is somewhat reminiscent of a small Catocala lar-
 va. Pupation occurs within a tough cocoon, into which chewed-up particles of wood-fiber (or other
 dry material) are incorporated. (See also Pleroma cinerea, which has the same larval feeding
 habits, and is present on Lonicera at the same time of year).
 •BENJAMINIOLA COLORADO Sm. (2435) (1) Oct. - Nov. - early Dec.; B
 BULIA ? SIMILARIS Rich. (3557) (1) June - Oct.; B- (2) Prosopis (S. C.)--This plant
 does not occur in the area.
 CAENURGIA TOGATARIA Wlk. (3433) (1) June - July - mid Aug.; Oct. - Nov.; B-
 CATABENA ESULA Druce (2741) (1) Aug. - Oct. - Nov.; B- (2) Ornamental Lantana
 (orange or yellow-flowered shrubby sp.)
 CATABENA LINEOLATA Wlk. (2737) (1) Feb. - Apr. - May - Aug.; B+ (2) Ver-
bena sp. (3) The deep green, slender larvae are often common on Verbena. They rest flatly-ap-
 pressed on the tops of leaves. If disturbed, they may drop and wriggle violently.
 CATABENA SAGITTATA B. and McD. (2738) (1) Oct. - Nov.; B-
 CATOCALA AHOLIBAH Stkr. (3341) (1) Mid July; C₁ (2) Quercus spp.
 CATOCALA IRENE Behr (3348) (1) Mid June - Aug.; C (2) Salix (S. C.) (3) Easily
 alarmed in the daytime.
 CATOCALA PIATRIX DIONYZA Hy. Edw. (3312a) (1) July - Sept.; E- (2) Juglans
 (S. C.)
 CATOCALA VERRILLIANA Grt. (3390) (1) July - Aug.; B (2) Quercus spp.
 CHORIZAGROTIS AUXILIARIS Grt. (1387) (1) Apr. - early May; B-
 •CISSUSA INDECRETA Hy. Edw. (3542) (1) Mid Feb. - Mar. - early Apr.; (2)
Quercus.
 •CONOCHARES ACUTA Sm. (3162) (1) Late Mar. - Apr. - May - July - Aug.; Nov.; A
 (2) Franseria (C. H.)
 CONOCHARES ELEGANTULA Harv. (3164) (1) Late May - Aug.; B-
 COPICUCULLIA EULEPIS Grt. (2003) (1) May - July - Sept.; B+ (2) Stephano-
meria (C. H.)
 COSMIA CALAMI Harv. (2687) (1) Late May - June - July; A (2) Quercus agrifolia
 (3) Larvae are easily obtained by beating Quercus agrifolia when it is in new leaf, during March
 or April. A notable feature of the yellowish-green larva is that it tapers considerably at the pos-
 terior end. The adults are highly variable.
 •CUCULLIA DENTILINEA Sm. (2031) (1) Late Mar. - Apr. - May - mid June; B
 CUCULLIA ? LAETIFICA Lint. (2035) (1) Late Mar. - May - July - Sept.; B+ (2)
Corethrogyne filaginifolia (var. ?), and Haplopappus squarrosus (3) The colorful black, yellow,
 and white larvae (rarely with orange markings) are present in May and June. They feed in plain
 sight on the plant, and never hide. It is of interest to note that, in some years, the larvae are
 mostly on Corethrogyne; in other years, mostly on H. squarrosus. (In 1964, they were almost
 exclusively on Corethrogyne). This same pattern of switching foodplants is also seen in Melitaea
gabbii Behr, a common butterfly in the area, and the same two plants are involved.
 DARGIDA PRÓCINCTA Grt. (1952) (1) Apr. - June; Oct. - early Nov.; B- (2) Grass-
 es and various herbs, including clovers.
 EPIZEUXIS LUBRICALIS OCCIDENTALIS Sm. (3746a) (1) June; C (2) Larvae
 always found associated with rotten wood (S. C.); perhaps to be found in woodrat (Neotoma) nests.
 EREBUS ODORA L. (3525) (1) Early Aug.; C₁ (2) Ornamental Acacia trees, Cassia,
 and other woody legumes (J. C.)
 •EUBLEMMA MINIMA Gn. (3061) (1) Late Mar. - July - Aug. - mid Sept.; A (2)
 Floral heads of Gnaphalium (C. H.)
 •EUCLIDIA ARDITA Franc. (1) Mar. - Apr. - early May; diurnal only; B+ (4) Lotus
scoparius, and probably certain other herbaceous legumes (3) Larvae reared on Lotus scoparius
 were predominantly yellow-tan in ground color; they were quite slender. At first glance, the di-
 urnal adult (when on the wing) is sometimes mistaken for a skipper of the genus Erynnis (dusky-
 wings), but the skippers have a more erratic, darting flight.
 EUXOA ATOMARIS Sm. (1344) (1) Sept. - Oct. - Nov.; A
 EUXOA BREVIPENNIS Sm. (1233) (1) Sept. - Oct.; C
 EUXOA CICATRICOSA G. and R. (1234) (1) Late Oct.; C₁
 EUXOA FENISECA Harv. (1269) (1) Sept. - Oct. - Nov.; B+
 •EUXOA MEDIALIS Sm. (1307) (1) Oct. - Nov. - Dec.; A (3) This moth occurs in
 several color forms in this locality, ranging from gray to yellow-tan to reddish.

- EUXOA MERCEDES B. and McD. (1268) (1) Mid Oct. - Nov.; B- (3) The moth is present in a yellow-tan form, and a reddish form.
- EUXOA MESSORIA Harr. (1310) (1) Sept. - Oct. - Nov.; B
- EUXOA OLIVIA Morr. (1232) (1) Sept. - Oct. - Nov.; A (3) In this locality, the moth is quite variable in color, and somewhat variable in maculation.
- EUXOA SEPTENTRIONALIS Wlk. (1311) (1) July - Oct.; B
- EUXOA sp. (near *E. terrena* Sm., in appearance) (1) May - Oct.; B
- EUXOA ? SPONSA Sm. (1284) (1) May - June - July; A (3) The moth usually has a black collar, but this is variable.
- EUXOA SPONSA MONTECLARA Sm. (1284b) (1) May - June - July; A (3) This moth and the preceding may belong together.
- NOTE: There may be some species of *Euxoa* that were missed, as these moths were not as well-collected as they should have been; the data for this genus is spotty.
- FELTIA GENICULATA G. and R. (1451) (1) Mid June - July - Nov.; A
- FERALIA FEBRUALIS Grt. (2187) (1) Mid Dec. - Mar. - early Apr.; A (2) *Sambucus*, *Cercocarpus*, *Quercus*, *Ceanothus spinosus*
- FORSEBIA PERLAETA Hy. Edw. (3558) (1) Mid Sept.; C₁ (2) *Cercidium* (J. C.) --- This plant does not grow in the area.
- GALGULA PARTITA Gn. (2666) (1) Oct. - Nov.; C₁ (2) *Oxalis* (J. C.)
- HELIOTHIS PARADOXA Grt. (2929) (1) Early Oct.; C₁ (2) Floral heads of *Heterotheca grandiflora* (?) (One record; reared specimen lost).
- HELIOTHIS PHLOXIPHAGA G. and R. (2931) (1) Late Mar. - Oct.; diurnal and nocturnal; A (2) Flowers and buds of various plants, including *Pelargonium* (ornamental), and *Gilia*, etc.
- HELIOTHIS ZEA Boddie (2932) (1) July - Oct. - mid Nov.; B+ (2) Corn, tomato, etc. (S. C.)
- HELIOTHIS VIRESCENS Fabr. (2933) (1) May - Aug. - Dec.; B (2) *Ribes malvaecium*
- HEMEROPLANIS FINITIMA Sm. (3671) (1) Apr. - May - Oct.; B+ (3) The adult is quite variable.
- HEMIEUXOA RUDENS Harv. (1491) (1) Apr. - Oct. - Nov.; B+ (2) A general feeder
- HOMOGLAEA CARBONARIA Harv. (2322) (1) Mid Dec.; C₁ (3) The adult hibernates.
- HOMONCOCNEMIS FORTIS Grt. (2146) (1) Mar. - Apr.; Nov.; C (2) *Fraxinus* (C. H.)
- HOMONCOCNEMIS PICINA Grt. (1) Oct. - Nov. - Jan.; C (2) *Penstemon* (C. H.)
- (3) The adult is often found inside buildings.
- HOMORTHODES COMMUNIS Dyar (1891) (1) Aug. - Sept. - Oct.; B
- HOMORTHODES HANHAMI SEMICARNEA B. and McD. (1885a) (1) Feb.; May - June; A
- INCITA AURANTIACA Hy. Edw. (2921) (1) Apr. - mid May; diurnal only; C (2) *Gilia* - buds and flowers (C. H.)
- LACINIPOLIA CUNEATA GERTANA Sm. (1715) (1) Late Mar. - May - early June; A (2) A general feeder (S. C.)
- LACINIPOLIA ILLAUDABILIS Grt. (1751) (1) June - July - Aug. - Nov.; A (2) *Eriogonum fasciculatum*
- LACINIPOLIA PATALIS Grt. (1758) (1) Apr. - May - June; A (2) Various rosaceous plants; probably other plants (S. C.)
- LACINIPOLIA PENSILIS Grt. (1736) (1) Sept. - Oct. - Nov.; A (4) A general feeder (S. C.)
- LACINIPOLIA QUADRILINEATA Grt. (1757) (1) May; Sept. - Oct.; B+ (2) A general feeder; a specific record is *Adenostoma fasciculatum*
- LACINIPOLIA STRICTA TENSICA Sm. (1739b) (1) June; late Sept. - Oct.; C (2) A general feeder; *Eriogonum*, *Lactuca*, etc. (S. C.)
- LAPHYGMA EXIGUA Hbn. (= *Spodoptera*) (2683) (1) July - Sept. - Oct. - Nov.; A
- (2) A general feeder on low-growing plants.
- LAPHYGMA FRUGIPERDA A. and S. (2682) (1) Early Oct.; C₁
- LEUCANIA sp. (near *farcta* Grt., in general appearance) (1) Mar. - May - Aug. - Dec.; A
- LITHOPHANE CONTENTA Grt. (2233) (1) Oct. - Nov. - Dec.; B- (2) *Quercus* (S. C.) (3) The adult hibernates.
- LITOPROSOPUS COACHELLA Hill (3599) (1) May - June; Aug. - Sept.; C (2) *Washingtonia filifera* (fan-palm), grown as an ornamental in Beverly Hills.
- LYCANADES PURPUREA Grt. (2310) (1) Nov. - Jan.; A (2) A general feeder (3) The adult is highly variable in color and pattern.
- MAMMIFRONTIA RILEYI Barnes (2444) (1) June - Aug.; B+ (2) In stems of *Elymus condensatus*; pupates in old or dead stalks (J. C.)
- MELIPOTIS INDOMITA Wlk. (3549) (1) May - Aug. - Oct.; B+ (2) *Prosopis* (S. C.) --- This plant doesn't occur in the locality. (3) The adult is easily alarmed in the daytime.
- MICRATHETIS TRIPLEX Wlk. (2667) (1) May - June - Oct. - Dec.; B
- MIODERA STIGMATA Sm. (1797) (1) Mid Nov. - Dec. - Jan. - Feb.; A (2) *Artemisia californica* (3) The larvae are easily collected by beating, in March or April. Early instars are soft green, with white parallel lines; last instar larvae are nearly always light brown, with the same lines. They curl up tightly when handled.

- MOURALIA TINCTOIDES Gn. (3310) (1) Late Sept.; C₁ (2) Tradescantia fluminensis (ornamental Wandering Jew) (J. C.)
- *MYCTEROPHORA GEOMETRIFORMIS Hill (3714) (1) Aug. - early Sept.; B-
- *NEPERIGEA ALBIMACULA B. and McD. (2641) (1) Late June - July - early Aug.;
- B+
- OLIGIA DIVESTA Grt. (2557) (1) June - July; B (2) Grasses (S. C.)
- OLIGIA MARINA Grt. (2425) (1) Apr. - May - June - early July; A (2) Nemophila (C. H.), Pholistoma auritum (C. H.), Lithophragma (C. H.), Montia (C. H.)
- *OLIGIA TUSA Grt. (2414) (1) Late June - July - early Aug.; B-
- *ONCOCNEMIS PERSCRIPTA Gn. (2063) (1) Feb. - Mar. - mid Apr.; C (2) Antirrhinum, Linum, etc. (J. C.)
- *ONCOCNEMIS RAGANI Barnes (2124) (1) Late Mar. - Apr. - May - July - early Oct.; A
- (2) Lonicera subspicata (3) The moth is probably triple-brooded in this locality.
- *ONCOCNEMIS SINGULARIS B. and McD. (2102) (1) May - June - July; B+
- ORTHODES ALFKENI Grt. (1851) (1) July - Aug. - Sept. - Nov.; A
- ORTHODES PERBRUNNEA Grt. (1887) (1) Sept. - Oct.; B-
- ORTHODES RUFULA Grt. (1849) (1) Apr. - May; Sept. - Oct.; B+
- ORTHODES VARIABILIS B. and McD. (1853) (1) Sept. - Oct.; B
- *ORTHOSIA ARTHROLITA Harv. (1939), (1) Nov. - Dec.; B+
- ORTHOSIA ERYTHROLITA Grt. (1924) (1) Late Nov. - Dec. - Feb. - May; A (3)
- The moth is exceedingly variable in color and pattern, on the forewings.
- ORTHOSIA FERRIGERA Sm. (1929) (1) Mar.; C (2) Quercus
- ORTHOSIA HIBISCI QUINQUEFASCIATA Sm. (1943c) (1) Feb. - early Apr.; B-
- (2) General feeder on various trees and shrubs.
- ORTHOSIA MACONA Sm. (1931) (1) Jan. - Feb. - early Apr.; A
- ORTHOSIA PACIFICA Harv. (1942) (1) Jan. - Feb. - early Apr.; A (2) Quercus agrifolia; Arctostaphylos glauca (C. H.)
- ORTHOSIA PRAESES Grt. (1927) (1) Late Nov. - Dec. - Jan. - early Apr.; A (2) Sambucus, Ribes speciosum, Photinia arbutifolia, etc. (3) The adult is highly variable in color and pattern.
- ORTHOSIA TRANSPARENS Grt. (1926) (1) Apr. - May; C
- *PAECTES DECLINATA Grt. (3229) (1) May; July - Oct.; B (2) Rhus laurina (3)
- The larva tapers noticeably at the posterior end. It turns pinkish prior to pupation. In feeding, it makes a characteristic hole at the leaf edge, in that it often leaves a thin shred of the leaf margin still clinging at one side of the hole or the other. Smaller Rhus shrubs, growing in semi-shade, are preferred.
- PERIDROMA MARGARITOSA Haw. (1496) (1) Mar. - Nov.; A (2) General feeder on low plants.
- PERIGONICA TERTIA Dyar (1945) (1) Late Feb. - Mar.; B- (3) The moth is quite variable in color and maculation.
- *PLATYPERIGEA sp. (1) Late May; Aug. - Sept. - Oct.; B+
- PLATYSENTA ALBOLABES Grt. (2619) (1) Late Mar. - Apr. - July - Aug.; B
- *PLEROMA CINEREA Sm. (2029) (1) Late Oct. - Nov. - Dec. - Feb.; A (2) Lonicera subspicata; Symphoricarpos (S. C.) (3) References to behavior and feeding habits of the larvae of Behrensia conchiformis apply to this species as well. Although brown in color, the P. cinerea larva lacks the "caudal points" of Behrensia, and differs in details of maculation and morphology. It is also a "heavier" larva. (When collecting at night on Lonicera, chances are greater for finding P. cinerea larvae, as they are more abundant than Behrensia).
- *PLEROMA CONSERATA Grt. (2025) (1) Late Jan. - Feb. - mid Mar.; C (2) Symphoricarpos mollis; Lonicera? (3) A confined female laid many eggs on a sprig of Symphoricarpos, in a gallon jar. The larvae will die prior to pupation, if provided only with soil; they require dry, fibrous wood or papery, shredded bark, upon which they make tough cocoons.
- POLIA MONTARA Sm. (=nipana Sm.?) (1706) (1) Mid June - July - early Aug.; B
- PRODENIA ORNITHOGALLI Gn. (2678) (1) May - Oct.; B- (2) General feeder (S. C.)
- PRODENIA PRAEFICA Grt. (2679) (1) Feb. - July - Aug. - Dec.; B (2) General feeder (S. C.)
- *PROTOPERIGEA POSTICATA Harv. (2673) (1) Sept. - Oct. - Nov.; A
- (3) There may be two moths involved here; if not, it is rather variable in size and maculation.
- PSEUDALETIA UNIPUNCTA Haw. (1994) (1) Mar. - Nov.; A (2) Elymus condensatus, and other grasses, etc.
- PSEUDOBRYOMIMA FALLAX Hamp. (2174) (1) Feb. - Mar. - Apr. - May; Oct. - Nov. - Dec.; B- (3) The moth is quite variable in ground color (yellow-tan to reddish).
- PSEUDOGLEA OLIVATA Harv. (1574) (1) Mid Sept. - Oct. - early Dec.; A (2) General feeder on woody plants; Quercus, Populus, Symphoricarpos, etc. (S. C.) (3) The forewings are highly variable in ground-color (from brick-red to brown to very pale tan to gray).
- *PSEUDORTHOSIA VARIABILIS Grt. (1403) (1) Late Sept. - Oct. - mid Nov.; A (2) Eriogonum fasciculatum (C. H.), and other plants (3) The moth is highly variable as to intensity of maculation on the primaries.
- RANCORA COMSTOCKI McD. (2012) (1) Early Feb.; C₁ (2) Malacothrix (C. H.)
- RANCORA SERRATICORNIS Lint. (2011) (1) Jan. - Feb. - Mar.; B-
- RHYNCHAGROTIS EXERTISTIGMA Morr. (1605) (1) Apr. - May - Oct.; A (3)
- The moth is highly variable in color and maculation.
- *SCHINIA BUTA Sm. (2971) (1) July - Aug.; C (2) Brickellia californica (C. H.)
- SCOTOGRAMMA DEFESSA Grt. (1624) (1) July; C
- SCOTOGRAMMA TRIFOLII Rott. (1633) (1) Apr. - Sept.; B (2) General feeder (S. C.)

- SEPTIS ALBINA Grt. (2350) (1) Late Apr. - May; B-
 • SEPTIS CINEFACTA Grt. (2359) (1) Mar. - Apr.; B+
 • SEPTIS CUCULLIFORMIS Grt. (2327) (1) Late Apr. - May; B- (2) Elymus con-
densatus, and other grasses (S. C.)
 • SPAELOTIS HAVILAE Grt. (1473) (1) May - early June; B-
 • STRETCHIA INFERIOR Sm. (1919) (1) Late Dec. - Feb. - Mar.; B+ (2) Ribes
speciosum (3) Highly variable in maculation and coloring.
 • SYNEDOIDA DIVERGENS form SOCIA Behr. (3573) (1) Mar. - July - Aug. - Oct. -
 Nov.; A (2) Sambucus (C. H.) (3) See remarks under S. ochracea.
 • SYNEDOIDA EDWARDSI Behr. (3571) (1) Apr. - May - July - Aug.; A (2) Rhus
trilobata (C. H.) (3) See remarks under S. ochracea.
 • SYNEDOIDA FUMOSA BRUNNEIFASCIATA B. and McD. (3568a) (1) Mar. - July
 - Oct.; B+
 • SYNEDOIDA OCHRACEA Behr. (3572) (1) Mar. - May - July - Oct.; A (3)
 These moths are often inclined to sit on the warm, dusty ground of dirt roads or trails, especially
 during the afternoon in hot weather. When approached, the moth flies up, only to land again a
 short distance ahead. The colorful secondaries flash orange as it flies away. (These remarks al-
 so apply to some other Synedoida spp., but S. ochracea is the one most often seen by day in this
 locality. All of them come readily to light as well).
 • SYNEDOIDA PALLESCENS G. and R. (3567) (1) Mid Sept. - Oct.; C
 • SYNEDOIDA TEJONICA Behr. (3582) (1) Oct.; C
 • TARACHIDIA CANDEFACIA Hbn. (3176) (1) July - Aug.; B-
 • TETANOLITA PALLIGERA Sm. (3779) (1) June - July; C (2) Dead leaves (S. C.)
 • TRICHOCLEA ANTICA Sm. (1649) (1) Mid Mar. - May; Aug. - Sept.; B
 • TRICHOLOPIS FISTULA Harv. (1824) (1) Late Sept. - Oct. - early Dec.; A
 • TRICHOPLUSIA NI BRASSICAE Riley (3269) (1) Apr. - Dec.; B+ (2) General
 feeder on numerous herbs: Brassica, Solanum, etc.
 • ULOLONCHE DILECTA Hy. Edw. (1836) (1) Sept. - Oct. - mid Nov.; B+
 • XYLOMYGES CRUCIALIS Harv. (1909) (1) Feb. - Mar. - mid Apr.; B+ (2) Quer-
cus agrifolia (3) In collections, this species is sometimes confused with X. simplex Wlk.
 • XYLOMYGES CURIALIS Grt. (1912) (1) Jan. - Feb. - Mar.; A (2) Amorpha cali-
forica (C. H.), and many other plants (3) Because of a similarity in spelling, this species is
 sometimes confused with X. crucialis Harv.
 • XYLOMYGES HIEMALIS Grt. (1906) (1) Late Nov. - Dec. - mid Mar.; A
 • XYLOMYGES PERLUBENS Grt. (1916) (1) Jan. - Feb. - Mar. - mid Apr.; A (2)
Ribes, and other plants.
 • XYLOMYGES RUBRICA Grt. (1915) (1) Feb. - Apr.; B- (3) Adults are of a very
 drab color-phase in this locality.
 • ZALE LUNATA Dru. (3474) (1) Apr. - July - Aug.; B (2) Salix (S. C.), Quercus,
Wisteria, Pyracantha, etc. (3) The adult is quite variable.
 • ZALE TERMINA Grt. (3497) (1) Early Apr.; C₁
 • ZOSTEROPODA HIRTIPES Grt. (1955) (1) Mid Feb. - July - Aug. - Sept.; B+ (2)
 Primarily grasses and herbs; also some woody plants (S. C.)
 • ZOTHECA TRANQUILLA Grt. (2686) (1) June - early July; B (2) Sambucus mexi-
cana (3) Only the brown phase of the adult has been collected here. The very colorful yellow and
 black larvae make tightly-closed leaf-nests on Sambucus (Mar. - Apr.). The nest usually consists
 of one leaflet folded down the middle, and closed with whitish silk. The larva rests in a tightly-
 curled position, within the nest. If handled, it will usually "spit", and curl up. If larvae are pre-
 sent at all, they are usually abundant on a single plant.

IX. Family DIOPTIDAE

- PHYRGANIDIA CALIFORNICA Pack. (3821) (1) Apr. - May - July; Nov.; A (2)
Quercus agrifolia (3) Adults are most active in the afternoon and early evening, when the males
 swarm about the oaks, with a weak, dancing flight. They also come to lights after dark. The pop-
 ulation fluctuates from year to year. In years of heavy infestation, the larvae are so abundant on
 oaks that their falling frass sounds like light rain. The pupa is unique among moths in this local-
 ity, as it is attached by its cremaster, and hangs head downward. Most of the pupae are on the
 trunks and branches of oaks.

X. Family NOTODONTIDAE

- CERURA CINEREA Wlk. (3935) (1) July; C (2) Populus
 • SCHIZURA ? UNICORNIS A. and S. (3924) (1) Apr. - May - July; Sept.; B+

XI. Family LIPARIDAE

- HEMEROCAMPA ? GULOSA Hy. Edw. (1) May - June - July - early Aug.; A (2)
 General feeder on numerous woody plants; five examples are Quercus, Ceanothus, Photinia arbut-
ifolia,
ifolia, Wisteria, and Eriogonum fasciculatum (3) The female is wingless, and remains on her co-
 coon until the eggs are laid. The males are diurnal (primarily afternoon), and nocturnal.

XII. Family LASIOCAMPIDAE

- EPICNAPTERA AMERICANA CARPINIFOLIA Bdv. (3999a) (1) Jan. - Feb. -
Mar. - May - June; B+ (2) Populus, Salix, Alnus, etc.
 • GLOVERIA GARGAMELLE MEDUSA Stkr. (3971a) (1) Late June - July - Aug. - early
Sept.; male diurnal only; B+ (2) Eriogonum fasciculatum and Quercus agrifolia; Rhus laurina
 (record of Oakley Shields, in San Diego County) (3) The fast-flying diurnal male is rarely seen, but

if a freshly-emerged female is placed in a cage (outdoors), males will arrive quickly; they are most active from 10:00 A. M. to 3:00 P. M. The females fly primarily after dark, although one is occasionally seen on the wing late in the afternoon, before sunset. The female is the commonest large moth at lights in this locality, during mid-summer. Sexual dimorphism is notable in the adults, the male being much smaller than the female and of a completely different color (rich rust-brown). The larvae are somewhat gregarious when small, but eventually become solitary. They grow slowly from September or October until the following May or June. They feed for only a few minutes each night, and spend all the rest of the time hiding on the lower, woody stems of the food plant.

*TOLYPE ? LOWRIE B. and McD. (3981) (1) July - mid Aug.; A (2) Ceanothus megacarpus (C. spinosus not accepted) (3) The egg stage lasts from Aug. until the following spring, when the larvae hatch and rapidly complete growth by June. Adults come to light more abundantly after midnight.

XIII. Family GEOMETRIDAE

*AETHALOIDA PACKARDIA Hlst. (4947) (1) Mar. - May - Aug. - Nov. - early Dec.; B+ (2) Ceanothus, Adenostoma, etc. (J. C.)

ANACAMPTODES FRAGILARIA Grossb. (4914) (1) Mar. - May - June - Nov.; 1+ (2) Nicotiana glauca, and other trees and shrubs.

ANACAMPTODES ? PROFANATA B. and McD. (4927) (1) Mar. - June - July; A (2) Cercocarpus betuloides.

ANIMOMYIA INCRESCENS Dyar (4984) (1) Late May; C₁ (2) A. smithi Pears. has been reared on Franseria dumosa (C. H.)

*APICIA FALCATA Pack. (5175) (1) May - June - early July; Sept. - Oct.; B+ (3)

The moth is somewhat variable in color and maculation.

*BAPTA ELSINORA Hlst. (4607) (1) Mar. - May; B+

CAMPTOGRAMMA NEOMEXICANA Hlst. (=Archiloe) (4567) (1) Jan. - June - Oct. - Dec.; B (2) Mirabilis (C. H.)

CHLOROCHLAMYS HESPERIA Sperry (1) Late Apr. - May - Oct.; B (2) Flowers of Eriogonum fasciculatum (3) The larva is long and slender, without any lateral lobes or points such as are present on the larvae of Chlorosea, Dichorda, Nemoria, and Synchlora, etc. The head is cleft at the top. It does not cover itself with bits of floral parts or other debris. The adults sometime s emerge pinkish-brown instead of the usual dull green.

CHLORSEA GRACEARIA Sperry (1) May - June; B- (2) Blossoms of Adenostoma fasciculatum (C. H.); C. banksia Sperry on Ceanothus (Rindge, 1949); leaves of Cercocarpus betuloides (3) The larvae do not decorate themselves with bits of plant debris.

*COCHISEA SINUARIA B. and McD. (4970) (1) Late Oct. - Nov. - early Dec.; B (2) Rhus laurina, Cercocarpus betuloides, Arctostaphylos, etc. (3) The rather soft-shelled eggs are laid tightly side by side in one or more large, flat masses, in a crevice. (The female has a long ovipositor). The mature larvae are very large and "stick-like", ranging in color from gray-brown to pinkish brown, to olive green marked with brownish. The large, heavy pupae are sometimes found in the soil, under suitable foodplants.

CONIODES PLUMOGERRARIA Hlst. (4955) (1) Jan. - Feb. - Mar.; B+ (2) Juglans, Quercus (J. C.) (3) The female is wingless, but occasionally crawls to light.

*COSYMBIA DATARIA PIAZZARIA Wgt. (4208) (1) Mar.; June - July - Aug.; Nov. - early Dec.; B+ (2) Hemizonia flowers; on the yellow flowers of this foodplant, the larvae were deep yellow all over.

COSYMBIA SERRULATA Pack. (4212) (1) June - Aug.; Dec.; B- (2) Flower heads of Encelia californica, Haplopappus, and blossoms of certain other composites (C. H.)

*DICHORDA ILLUSTRARIA Hlst. (4084) (1) Apr. - July - Aug. - Jan.; B+ (2) Rhus laurina; R. trilobata, in the San Gabriel Mts. (3) The larvae do not attach bits of plant material to themselves.

DREPANULATRIX BIFILATA Hlst. (4618) (1) June - Aug. - Sept. - Nov.; A (2) Cercocarpus

DREPANULATRIX FALCATA Pack. (4622) (1) Dec. - Jan. - Feb. - Mar.; B+ (2) Ceanothus (Rindge, 1949)

*DREPANULATRIX HULSTII Dyar (4632) (1) Mar. - Nov.; A (2) Ceanothus ?; Rhamnus crocea

DREPANULATRIX MONICARIA Gn. (4619) (1) Feb. - June; Oct. - Dec.; A (2) Ceanothus megacarpus, C. spinosus

DREPANULATRIX CUADRARIA USTA Rindge (4633) (1) Jan. - June; Sept. - Nov. - Dec.; B+

DREPANULATRIX UNICALCARARIA Gn. (4634) (1) Recorded for every month; "peaks" around Apr. - June, and Sept. - Oct.; A (2) Ceanothus (Rindge, 1949)

*DYSTROMA HULSTATA Tayl. (4425) (1) Late Apr. - May - June; A (2) Lithophragma (C. H.)

EPIRRHOE PLEBECULATA Gn. (4549) (1) Dec. - Feb. - Mar.; diurnal only; B+ (2) Galium

*EUPITHECIA ACUTIPENNIS Hlst. (4374) (1) Nov. - Dec. - Feb.; A (2) Artemisia californica (Rindge, 1952)

EUPITHECIA GILVIPPENNATA C. and S. (4370) (1) Late Nov. - Dec. - mid Jan.; C EUPITHECIA MADUNNOUGHII Rindge (1) Recorded for Dec. through Aug., with "peaks" around Mar. and July - Aug.; A

EUPITHECIA MISTURATA Grt. (4267) (1) Dec. - Feb. - Mar.; A (2) Baccharis pilularis (Rindge, 1952)

•EUPITHECIA NEVADATA Pack. (4375) (1) Late Dec. - Feb. - Mar.; A (2) Lotus scoparius (3) The dark green larva has an intense red-purple lateral line, edged above by yellowish-white.

EUPITHECIA ROTUNDOPUNCTA Pack. (4285) (1) Mar. - Apr.; B+
EUPITHECIA SHIRLEYATA C. and S. (4373) (1) Feb. - Mar. - Apr.; A (2) Marah (= Echinocystis) macrocarpus (Rindge, 1952)

NOTE: There may be some species of Eupithecia that were missed, as these moths were not as well-collected as they should have been; the data for this genus is spotty.

EUSTROMA SEMIATRATA Hlst. (4398) (1) June; B (2) Epilobium (J. C.)
 •GLAUCINA EPIPHYSARIA Dyar (4827) (1) Feb. - May - Oct. - Dec.; A
 •HESPERUMIA SULPHURARIA Pack. (and forms) (4801) (1) May - June - July; A
 (2) Ceanothus spp. (J. C.), Cercocarpus betuloides (C. H.), Arctostaphylos glauca (C. H.) (3) The adults are highly variable in color and pattern.

HULSTINA INCONSPICUA Hlst. (4932) (1) May - June - July; B+ (2) Ceanothus spinosus, and the blossoms of Adenostoma fasciculatum

•HULSTINA WRIGHTIARIA Hlst. (1) May - June - July; A
 •HYDRIOMENA ALBIFASCIATA Pack. (4467) (1) Dec. - Feb.; A (2) Quercus agrifolia (on new leaves, in Mar.) (3) Typical albifasciata (marked with white) is present, but uncommon; the usual form in this locality lacks all white.

HYDRIOMENA EDENATA Swett (subspecies?) (4495) (1) Feb. - Mar. - early Apr.; B
 •HYDRIOMENA NUBILOFASCIATA Pack. (4469) (1) Jan. - Feb. - early Mar.; A
 (2) Quercus agrifolia (on new leaves, in late Mar.) (3) The adults are often seen flying in the daytime, especially in shady ravines. (They are easily disturbed to activity). On mild, cloudy days, they fly more. The larvae are abundant on oak, in March and early April. They rest in a half-curved posture within leaf nests; usually the nests are of two overlapping leaves, tied flatly together with some silk. The larva is short and fairly plump, and is mostly white or cream marked with black. The small pupa is reddish-brown. The pupal stage lasts from 8 to 10 months. The adults vary tremendously in color and maculation of the forewings.

•ITAME EXTEMPORATA B. and McD. (4758) (1) Late Mar. - Apr. - early June; B
 (2) Cercocarpus betuloides
 •ITAME GUENEARIA Pack. (4765) (1) Apr. - May - June - early Aug.; A (2) Rhamnus crocea (3) The larvae are present in May and June.

ITAME QUADRILINEARIA Pack. (4757) (1) July; B-
 •LITHOSTEGE ANGELICATA Dyar (4218) (1) May - June; C
 •MEROCHLORA FASEOLARIA Gn. (4106) (1) Mar. - Apr.; Oct. - Nov.; B+ (2) Artemisia californica (3) A series of 17 close-up photographs, depicting the life history of this moth, are presented in an article entitled "A Sagebrush Cinderella", by George E. Jenks, in Nature Magazine, Vol. 39, No. 7 (Aug. - Sept. 1946). (In that article, the moth is identified as "Nemoria californica"). The larvae decorate themselves with bits of plant material (scraps of floral parts and leaves).

•NASUSINA INFERIOR Hlst. (4251) (1) Mar. - Apr. - May; B+
NASUSINA VAPORATA Pears. (4252) (1) Mar. - Apr. - May; A (2) Blossoms of Adenostoma fasciculatum

NEMORIA DELICATARIA Dyar (4052) (1) Dec. - June - Aug.; B (2) Heteromeles arbutifolia (= Photinia) (J. C.)

NEMORIA PUNCTULARIA B. and McD. (4060) (1) Mar. - May - July; Oct. - Nov.; B+
 (2) Ceanothus spinosus; Quercus (J. C.)

NEOTERPES EDWARDSATA Pack. (5159) (1) Late Apr. - May; Aug.; Oct.; C (2) Dendromecon, Romneya (J. C.)

•NOTHOPTERYX VERITATA Pears. (4224) (1) Mid Feb. - mid Mar.; B

OPOROPHTERA OCCIDENTALIS Hlst. (4241) (1) Late Dec. - Jan.; C (3) The female is wingless.

•PALAEACRITA LONGICILIATA Hlst. (4959) (1) Dec. - Jan. - Feb.; B (2) Adenostoma fasciculatum (record of Frank Sala) (3) The female is wingless.

•PAREXCELSA ULTRARIA Pears. (4854) (1) Late Sept. - Oct. - Nov.; A (3) Both sexes come readily to light.

PERCNOPTILOTA OBSTIPATA Fabr. (4535) (1) Apr. - June; Oct. - Nov.; B- (2) Various low-growing plants (J. C.)

PERIZOMA CUSTODIATA Gn. (4586) (1) Early Dec.; C₁ (2) Atriplex spp., Grayia spinosa (J. C.)

PERO MACDUNNOUGHII C. and S. (1) Mar. - Apr. - July; Oct. - Nov.; A (2) Rhamnus crocea, Eriogonum fasciculatum (J. C.), Artemisia californica (J. C.), and other trees and shrubs.

•PHILOBIA ASPIRATA Pears. (4668) (1) Feb. - Mar. - June - Aug.; A (2) Juglans californica

•PHRENE SUBPUNCTATA Hlst. (5174) (1) Jan. - Mar. - June - Nov. - Dec.; recorded for every month; "peaks" underlined; B+ (2) Salvia mellifera (C. H.) (3) The moth is variable in size and color.

•PLATAEA PERSONARIA Hy. Edw. (1) Mar. - May - June; Oct. - Nov. - Dec.; B+ (2) Artemisia californica

PROCHOERODES FORFICARIA Gn. (5210) (1) Jan. - Mar. - Apr. - June - July; B+ (2) Salix (J. C.)

•PTEROTAEA AGRESTARIA Grossb. (4940) (1) May - June - July; A (2) Adenostoma fasciculatum blossoms

•PTEROTAEA NEWCOMBI Swett (4937) (1) Late June - early July; B- (3) Most of these moths come to light between 2 A.M. and 4 A.M.

PTEROTAEA ? SERRATARIA B. and McD. (4939) (1) June - mid July; B+

SABULODES CABERATA Gn. (5089) (1) Apr. - Sept.; C (2) Due to its wide range of foodplants, this moth has received the common name of "omnivorous looper". In gardens, it often feeds on ivy. (3) This species is much more abundant in city gardens than in areas of undisturbed vegetation.

SCOPULA QUINQUELINEARIA Pack. (4144) (1) Late May - June; B

SEMIOTHISA CALIFORNIARIA Pack. (4694) (1) Mar. - Dec.; A (2) *Lotus scoparius*

SEMIOTHISA COLORATA Grt. (4693) (1) Late June; C₁

SEMIOTHISA EXCURVATA Pack. (4713) (1) Late Jan. - Mar.; Oct. - Nov.; B- (2) *Juniperus* (C. H.) --- This plant does not occur in the area.

SEMIOTHISA NEPTARIA Gn. (4725) (1) July - Sept.; C (2) *Salix*

SEMIOTHISA PICTIPENNATA Hlst. (4716) (1) Late Dec.; C₁

SERICOSEMA JUTURNARIA Gn. (4645) (1) May - June - July; diurnal and nocturnal; B- (2) *Rhamnus* (Rindge, 1950); *Ceanothus* (?) (3) *Sericosema* adults always rest with the wings up, over the back. See remarks under *S. similaria*.

**SERICOSEMA SIMILARIA* Tayl. (4648) (1) May - June - July; diurnal and nocturnal; B+ (3) The adult behaves somewhat like *Coenonympha*, and flies in much the same places preferred by that butterfly: along roadsides, in semi-shade of large shrubs, and in grassy or weedy fields. When approached, the moth flies up vigorously, but lands again a short distance away, usually on the ground and with its wings folded up over its back. *Sericosema* spp. also come readily to lights at night.

SICYA MACULARIA LEWISI Swett (5161c) (1) May - June; A (2) *Ceanothus spinosus* (3) The pupa is brilliant in color, with a rich silvery-pearl surface luster.

SICYA SNOVIARIA Hlst. (5163) (1) May - July; C (2) *Phoradendron flavescens*;

Quercus (3) This species also has a brilliant pupa, which is green, with a gleaming silvery-pearl surface luster. As the pupa ages, the surface luster becomes more intense. Occasional pupae are speckled and streaked with black; such pupae have a bronze-silver luster, and show little (if any) green.

**SLOSSONIA RUBROINCTA* Hlst. (5056) (1) June - mid July; B+ (2) *Quercus dumosa* (J. C.) (3) The adult always rests with its wings up, over the back.

SPARGANIA MAGNOLIATA QUADRIPUNCTATA Pack. (4555b) (1) Mar. - Apr.; late Nov.; B (2) Members of the Onagraceae (J. C.)

**STAMNOCTENIS COSTIMACULA* Grossb. (1) Nov. - Dec.; B (3) Upper surface of wings always grayish, with a sheen, but never "pearly" white as in *S. ululata*. Maculation prominent along costal margin of forewing.

**STAMNOCTENIS ULULATA* Pears. (4458) (1) Oct. - Nov. - early Dec.; B- (3) Adults always rest with wings up, over the back. Males rarely come to lights.

STAMNODES AFFILIATA Pears. (4438) (1) Nov. - Dec. - Feb.; B+ (2) *Salvia mellifera* (C. H.), *Salvia apiana* (C. H.) (3) This species, and the following *Stamnodes* spp., always rest with the wings up, over the back.

STAMNODES ALBIPICATA Grossb. (4436) (1) Feb.; C (2) *Pholistoma auritum* (C. H.), *Nemophila* (C. H.), *Phacelia cicutaria* (C. H.)

**STAMNODES ANSELLATA* Hlst. (4441) (1) Dec. - Feb. - Apr.; A (2) *Cercocarpus betuloides* (C. H.)

STAMNODES COENONYMPHATA Hlst. (4442) (1) Feb. - Mar.; A (2) *Cercocarpus betuloides* (3) This species is often active in the daytime, especially in shady ravines. (Other *Stamnodes* spp. are easily disturbed to activity in the daytime).

STENASPILATES APAPINARIA Dyar (5069) (1) Mar. - July - Aug. - Nov. - Jan.; B+ (2) *Salix* (J. C.), *Lonicera* (J. C.) (3) These moths are variable in color and details of maculation.

STERRHA BONIFATA Hlst. (4176) (1) All year (summer in particular); B+ (2) Oatmeal, raisins, dried plants, etc. (3) The moth rarely comes to light--in fact, it seems to avoid light whenever possible. It is most often seen indoors, where it rests on walls, curtains, etc. It is a very weak flier.

STERRHA sp. (1) June - July - early Aug.; B (3) The wings of this moth have a glossy surface-sheen.

SYNAXIS CERVINARIA Pack. (5191) (1) Mar. - Apr. - May - June; A (2) *Populus*, *Quercus*, etc. (3) The adults vary from dull brown and tan to bright orange-brown.

**SYNAXIS HIRSUTARIA* B. and McD. (5195) (1) Oct. - Nov.; B (2) *Cercocarpus betuloides* (C. H.), *Ribes malvaceum* (C. H.) (3) The adults vary from dark gray to various shades of brown, and the wings are often heavily speckled.

SYNCHLORA LICUORARIA Gn. (4073) (1) Mar. - July; Oct. - Nov.; B (2) Flowers of *Eriogonum fasciculatum*, *Artemisia californica*, etc. (3) These larvae decorate themselves with bits of floral parts and other debris, as do the larvae of *Merochlora fassolaria* Gn.

**THALLOPHAGA TAYLORATA* Hlst. (5019) (1) Dec. - Jan.; May - June; Aug.; B- (2) *Tornos erectarius* Fieldi Grossb. (4817) (1) May - July - Aug. - Oct. - Jan.; B+

TRIPHOSA CALIFORNIATA Pack. (4245) (1) Jan. - Feb. - Mar.; A (2) *Rhamnus crocea* (3) The short, plump, and colorful larvae are present in May and June. During the day, the larva rests in a slight nest between two leaves; it feeds after dark.

VENUSIA DUODECEMLINEATA Pack. (4590) (1) Jan. - Mar.; diurnal and nocturnal; B+

**ZENOPHLEPS LIGNICOLORATA* Pack. (4531) (1) Mar. - early Apr.; Oct. - Nov. - mid Dec.; A (2) *Galium angustifolium* (preferred), *G. nuttallii* (3) The larvae are nocturnal feeders, and hide by day on the lower (woody) stems of perennial *Galium*. They are rather inactive, and will drop if alarmed, but not on silken threads. If handled, they usually remain rigidly stick-like. Many larvae of this species were collected by the author in February, 1964.

ZENOPHLEPS OBSCURATA Hlst. (4533) (1) Feb. - May - Aug.; B-

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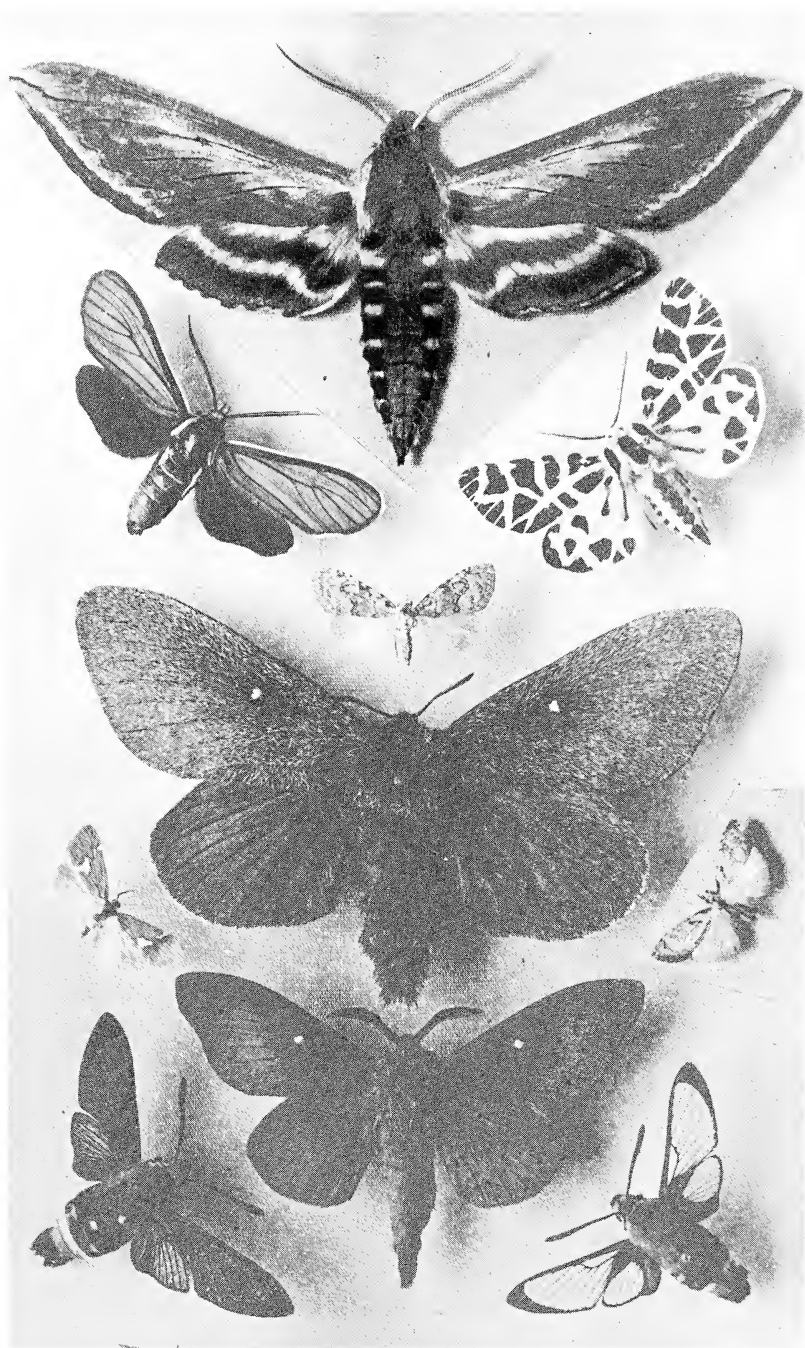
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EXPLANATION OF THE PLATES

Although it would have been ideal to figure all of the species covered in this paper, space was limited. Eighty five of the species — some common (and typical of the habitat), and some scarce or unusual records — were selected for illustration, with emphasis on well-marked specimens. All specimens are natural size, or very close to it. All specimens are from the same locality as indicated in the introduction to this paper. Dates are given in numbers, with the month FIRST. (Example: 3/5/54 = March 5, 1954).

1. *Sphinx ? perelegans* ♂ (Sphingidae), 5/25/55

2. *Ctenucha brunnea* ♂ (Amatidae), 3. *Apantesis ornata* ♂ (Arctiidae),
emerged 6/24/56 (reared from larva on *Elymus condensatus*) 4/28/57 (4:30 A.M.)

4. *Sarbenia minuscula eucalyptula* (Nolidae), 2/5/56

5. *Gloveria gargamelle medusa* ♀ (Lasiocampidae), 7/16/55

7. *Cisthene dorsimacula* ♂
(Lithosiidae), 6/15/55

8. *Celama minna*
(Nolidae), 5/20/57

6. *Gloveria gargamelle medusa* ♂ ,
emerged 6/28/55 (reared from larva
on *Eriogonum fasciculatum*)

9. *Hemaris diffinis thetis*,
freshly-emerged, having never
vibrated its wings; emerged 5/30/57
(reared from egg on *Lonicera Subspicata*)

10. *Hemaris diffinis thetis*
(Sphingidae), 3/26/57
(hovering over *Lantana*
blossom; diurnal)

PLATE I

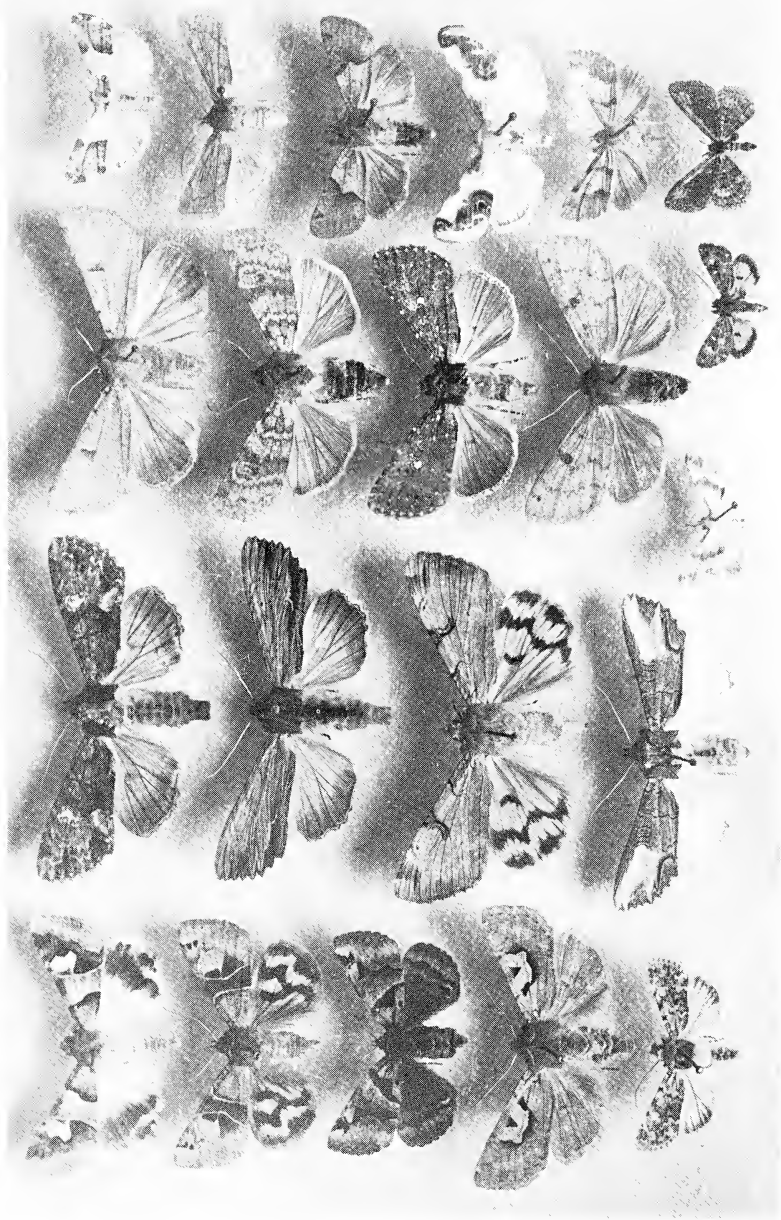


PLATE II

(all Noctuidae)

Column A (far left, from top to bottom)	Column B	Column C	Column D
1. <i>Synedroida pallescens</i> ♂, 10-10-55	1. <i>Septis albina</i> , 5/9/55	1. <i>Cissusa indescrcta</i> ♀, 3-5-54	1. <i>Conochares acuta</i> ♂, 7-9-55
2. <i>Synedroida edwardsi</i> ♀, 7-12-55	2. <i>Septis cuculliformis</i> , 5-18-55	2. <i>Euxoa medialis</i> ♀, 11-20-56	2. <i>Zosteropoda hirtipes</i> ♀, 8-28-56
3. <i>Euclidia arditia</i> ♀, emerged 3-23-58 (reared from egg on <i>Lotus scoparius</i>)	3. <i>Synedroida ochracea</i> ♀, 7-11-55	3. <i>Platysenta albolabes</i> ♀, 8-1-56	3. <i>Ulolonche dilecta</i> ♂, 9-27-55
4. <i>Acerra normalis</i> ♂, 2-13-56	4. <i>Admetovis similis</i> ♀, 4-29-55	4. <i>Orthosia arthrolita</i> ♀, 12-14-55	4. <i>Acontia cretata</i> ♂, 7-6-56
5. <i>Oncocnemis singularis</i> ♂, 5-17-57		5. (left of column) — <i>Eublemma minima</i> ♀, 7-6-55	5. <i>Hemeroplanis finitima</i> ♀, 6-6-56
		6. (right of column) — <i>Incita aurantiaca</i> , 4-21-56 (on ground; diurnal)	6. <i>Mycterophora geometrificomis</i> ♀, 8-29-56

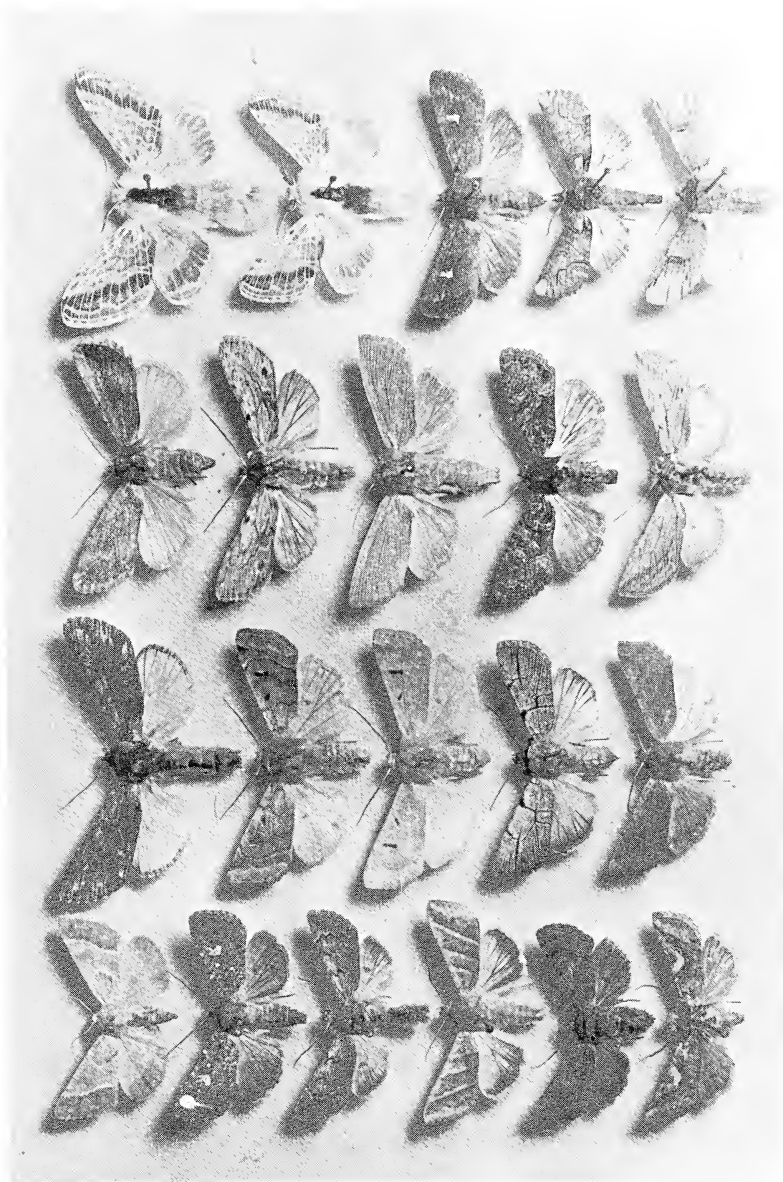
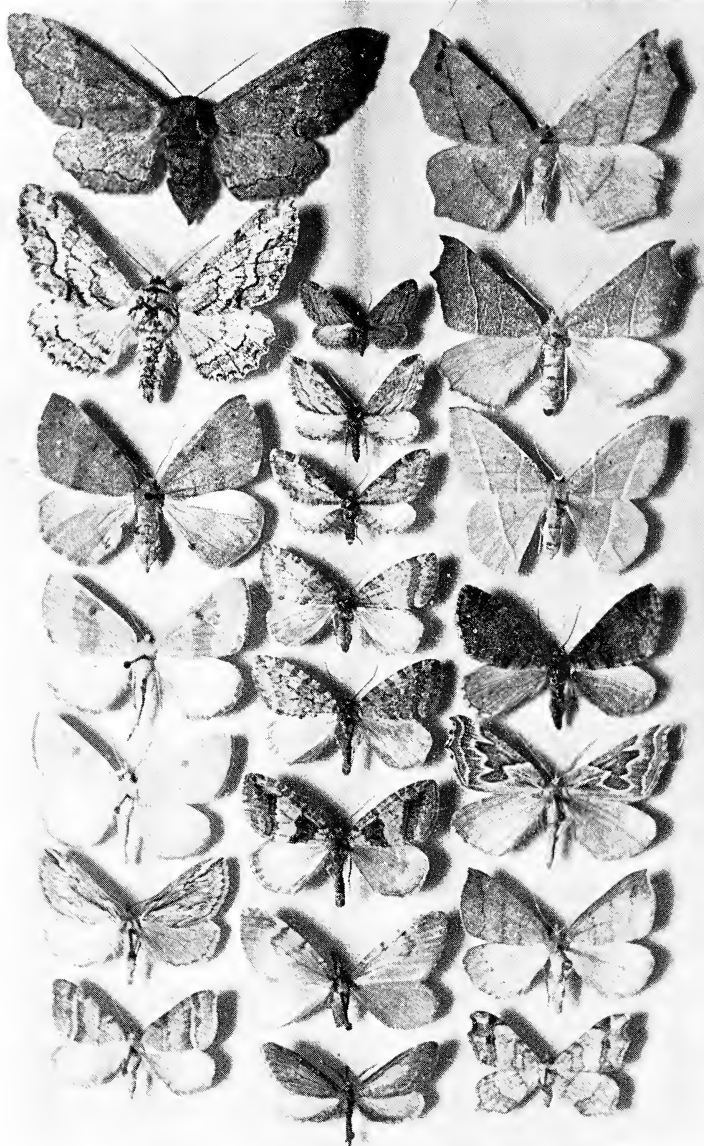


PLATE III

(all Noctuidae, except No. 1, 2, and 5, in Column D)

Column A (far left from top to bottom)	Column B	Column C	Column D
1. <i>Schinia buta</i> ♀, 7-31-54	1. <i>Acronycta othello</i> ♂, emerged 7-30-56 (reared from egg on <i>Rhus laurina</i>)	1. <i>Protoperigea posticata</i> ♀, 9-10-55	1. <i>Tolyte</i> ? <i>louriei</i> ♀ (Lasio-campidae), emerged 7-14-55 (reared from egg on <i>Ceanothus megacarpus</i>)
2. <i>Neperigea albimacula</i> , 7-26-55	2. <i>Pseudorthosia variabilis</i> ♂ (unusually dark specimen), 10-30-55	2. <i>Cucullia dentilinea</i> ♂, 3-29-56	2. <i>Tolyte</i> ? <i>louriei</i> ♂, emerged 7-16-55 (reared from egg on <i>Ceanothus megacarpus</i>)
3. <i>Pleroma conserta</i> ♂, 1-31-56	3. <i>Pseudorthosia variabilis</i> ♂ ("typical"), 10-3-55	3. <i>Beniaminiola colorado</i> ♀, 11-20-55	3. <i>Tricholita fistula</i> ♀, 10-23-55
4. <i>Heliothis virescens</i> , emerged 10-4-53 (reared from larva on <i>Ribes mabaceum</i>)	4. <i>Oncocnemis ragani</i> ♀, 7-30-56 (reared from egg on <i>Lonicera subspicata</i>)	4. <i>Oligia tusa</i> ♂, 7-12-55	4. <i>Paectes declinata</i> ♂, 7-15-56
5. <i>Behrensia conchiformis</i> suffusa ♀, 3-8-56	5. <i>Lycanades purpurea</i> ♂, 11-7-56	5. <i>Pleroma cinerea</i> ♂, 11-29-55	5. <i>Schizura</i> ? <i>unicornis</i> ♂ (Notodontidae), 6-9-56
6. <i>Stretchia inferior</i> , 1-15-56			



Col. A

B

C

PLATE IV
(all Geometridae)

Column A (far left, from top to bottom)

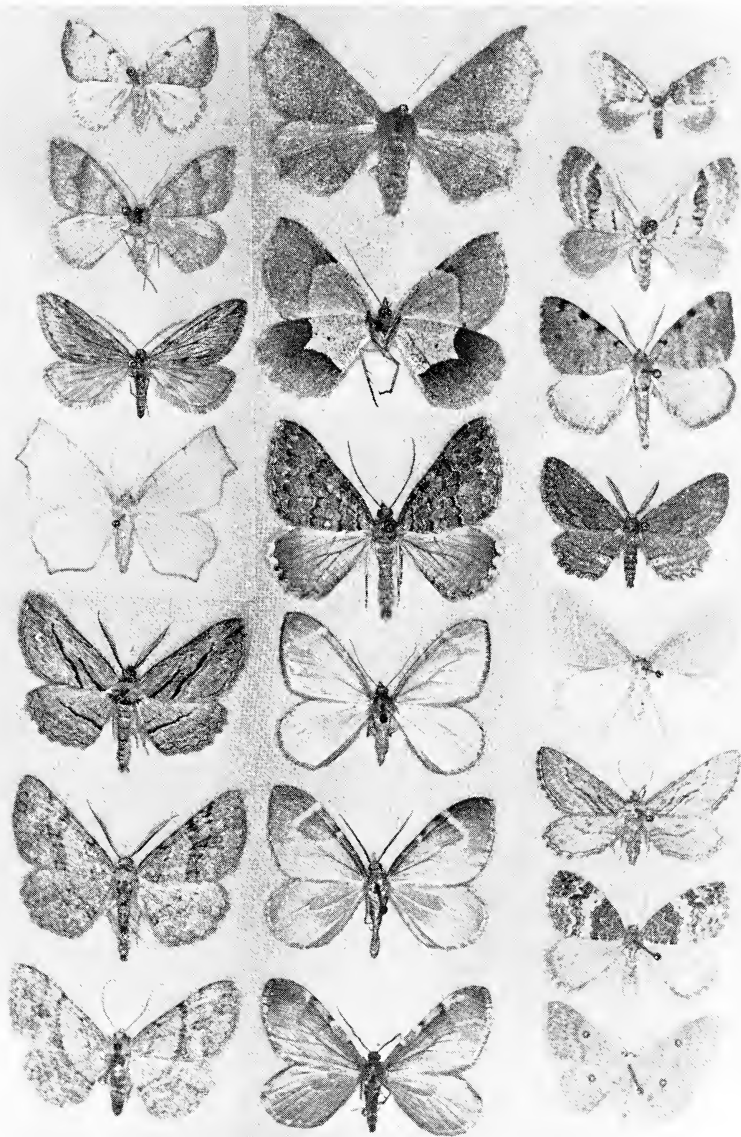
1. *Cochisea sinuaria* ♀, 11-22-54
2. *Cochisea sinuaria* ♂, emerged
11-15-56 (reared from egg on *Rhus*
laurina)
3. *Drepanulatrix hulstii* ♀, 10-21-56
4. *Hesperumia sulphuraria* ♀, 6-3-55
5. *Hesperumia sulphuraria* ♂, 6-23-55
6. *Parexcelsa ultraria* ♂, 9-25-56
7. *Itame guenearia* ♀, 6-21-57

Column B

1. *Nasusina inferior* ♀, 3-28-57
2. *Eupithecia acutipennis*, 12-11-56
3. *Eupithecia nevadata* ♀, 2-7-57
4. *Hydriomena nubilofasciata* ♀,
1-22-56
5. *Hydriomena nubilofasciata* ♂,
1-18-56
6. *Hydriomena nubilofasciata* ♂
1-22-56
7. *Stamnodes annellata* ♀, 2-8-57
8. *Glaucina epiphysaria* ♂, 11-4-56

Column C

1. *Apicia falcata* ♀, 6-4-55
2. *Phrene subpunctata* ♀, 4-12-55
3. *Dichorda illustraria* ♀, 11-9-55
4. *Hydriomena albifasciata* ♀, 12-9-55
5. *Plataea personaria* ♂, 3-23-56
6. *Thalophaga taylorata* ♀, 12-30-56
7. *Philobia aspirata* ♀, 3-26-55



Col. A

B

C

PLATE V

(all Geometridae)

Column A (far left, from top to bottom)

1. *Bapta elsinora* ♀, 3-15-56
2. *Zenophleps lignicolorata* ♀, 4-5-56
3. *Palaeacrita longiciliata* ♂, 12-16-55
4. *Slossonia rubrotincta* ♀, 6-22-55
5. *Pterotaea agrestaria* ♂, 6-4-55
6. *Pterotaea newcombi* ♂, 7-8-57 (4:00 A.M.)
7. *Pterotaea newcombi* ♀, 6-27-56

Column B

1. *Synaxis hirsutaria* ♀, 11-19-55
2. *Sericosema simularia* (underside; abdomen missing), 6-21-57
3. *Camptogramma neomexicana*, 1-24-56
4. *Stamnoctenis ululata* ♀, 11-4-56
5. *Stamnoctenis ululata* ♂, 11-3-56
6. *Stamnoctenis costimacula* ♂, 11-20-56

Column C

1. *Nothopteryx veritata* ♀, 2-26-57
2. *Lithostege angelicata* ♀, 6-26-56
3. *Itame extemporata* ♂, 4-9-56
4. *Aethaloida packardaria* ♂, 4-29-56
5. *Merochlora faseolaria* ♀, 4-13-55
6. *Hulstina wrightiaria* ♀, 6-3-55
7. *Dysstroma hulstata* ♂, 5-28-55
8. *Cosymbia dataria piazzaria* ♂, 6-25-55

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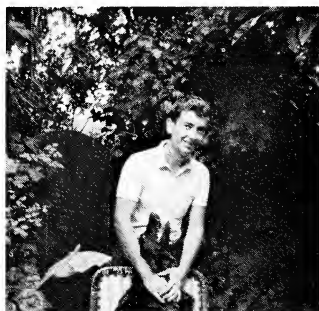
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THE LIFE HISTORY OF AMBLYSCIRTES BELLI IN MISSOURI

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THE NORTHERN LIMITS OF AMBLYSCIRTES BELLI Freeman are reached in western Missouri and eastern Kansas where isolated colonies are found as far north as the Missouri River. In southern Missouri the species becomes more numerous and ranges rather widely through the southern states. Recent works regard *A. belli* as a subspecies of *Amblyscirtes celia* Skinner which occurs abundantly in southern Texas. In Missouri *belli* is a local species occurring along shaded creek beds, primarily in secluded, undisturbed habitats. Adults can be found resting on the damp creek beds or sunning themselves on nearby plants. The host in this region is *Uniola latifolia* Michx. Once beds of this grass have been located along a woodland creek, the chances are good that a colony of *belli* will be present. The first brood appears in the latter half of May from overwintering larvae with subsequent broods occurring in July and September. The following life history studies are based on material obtained in St. Clair County, Missouri near Osceola. Ova layed 28 - 30 May produced imagines 9 - 19 July. Males and females emerge together

EGG: The eggs are hemispherical, slightly flattened at the vertex. Color clear white, surface smooth and shiny with no pattern. Width 1 mm. there is a darkening of the dorsal area on the fifth day. Eclosion occurs on the sixth day.

FIRST INSTAR LARVA: Freshly emerged larvae are snow white with a thick covering of medium length white setae. The head and prothoracic shield are shiny black. After emergence the larvae move to a point midway up a leaf and start construction of the larval tent at the edge of a leaf. These first instar tents are 10 to 23 mm. in length and are formed by curling under the edge

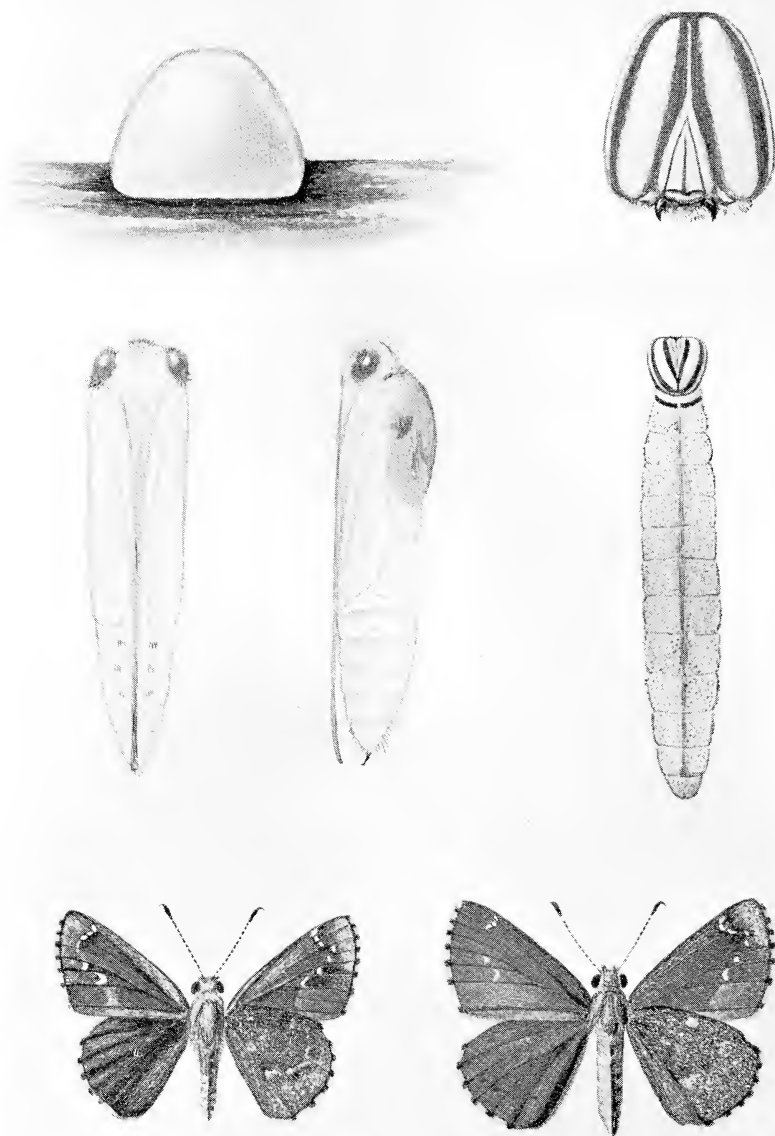


Fig. 1. The early stages of *Amblyscirtes belli*. Egg, lateral view. Mature larva and enlarged view of head capsule. Pupa, ventral and lateral view. Adult male and female, left side dorsal view, right side ventral view.

of the leaf and fastening it with strong silken strands. Larvae begin feeding on the second day and by the third day the body coloring has changed to a pale translucent green, paler posteriorly.

SECOND INSTAR LARVA: Body pale translucent green, thinly covered with short pale setae, those of the anal segment slightly longer. Prothorax paler green, prothoracic shield shiny black. Head unmarked, pale orange brown, sutures well defined, mandibles darker brown. The head bears a covering of minute white setae. Larval tent as in the first instar. The larvae are very pugnacious, thrashing the body about when the tent is touched. Larvae feed mostly at night with the day spent hidden away in the tent.

THIRD INSTAR LARVA: Body pale translucent green, thickly covered with a mixture of translucent and black setae. The anal segment is marked dorsally with a large black area composed in part of many short black setae. The spiracles are marked by small white raised dots and enclosed by a pale lateral band. The abdominal area is very pale greenish white. The prothoracic shield is shiny black, broader dorsally. Head pale orange brown with a broad vertical, grayish white band in each epicranial plate. The arms of the epicranial suture are narrowly edged with bands of the same grayish white. Mandibles bright reddish brown. Frons with two vertical white dashes. The entire head appears minutely pitted. A longer tent is constructed in this instar, 50 mm. in length along one side of a leaf. Larvae are very resentful of intrusion in this instar. If a light is shown on them or the leaf touched they throw their bodies wildly back and forth.

FOURTH INSTAR LARVA: Body translucent green, paler along the sides. The body is thickly covered with minute white setae. The dorsal area of the tenth abdominal segment is black with a covering of short black setae. The prothorax is white, the prothoracic shield shiny black. Head bright caramel brown with a white band edging the epicranial plates, narrow at the vertex, widest at the base of the jaws. There is a broad white band in the center of each epicranial plate starting at the base of the jaws and stopping just short of the vertex. The arms of the epicranial suture are edged outwardly with a narrow short white line. The frons are white with a caramel brown vertical dash. Mandibles darker brown. With the start of this instar a rapid increase in growth rate is noticeable. Larvae are more docile in this instar.

FINAL INSTAR LARVA: Length 23-27 mm. width of head case 2.25 mm. Body pale translucent green with a whitish overcast. There is a darker green middorsal line and a pale greenish

white lateral band along the sides. The intersegmental folds are pale yellow with small wrinkles between the folds. The body is thickly covered dorsally with short black setae changing to pale orange along the sides. The spiracles are marked by small white raised dots. The thoracic and anal spiracles are larger and narrowly ringed with black. Prothorax pale creamy white. The prothoracic shield is shiny black and is divided dorsally by a narrow white line. Head creamy white with orange brown bands. The posterior side of the head is ringed at the prothorax with a narrow orange brown band. The outer edges of the epicranial plates are banded from the vertex to the base of the jaws with orange brown and the arms and stalk of the epicranial suture are banded outwardly with the same color. The suture itself is marked by a pale white line, widest along the arms. The frons are white, narrowly, edged with orange brown and with a central dash of the same color. Labrum white, mandibles orange brown. The entire head is covered with short white setae. Final instar larvae construct their tent from an entire leaf and then devour the leaf from the tip back until only an inch or so of the tent remains. The old tent is then cut from the plant and the larvae move to another leaf where the procedure is repeated.

PUPA: Length 17-18 mm., width at wing cases 4 mm. Head and wing cases pale cream colored. Thorax light orange brown, abdomen pale yellow with pale orange rings at each intersegmental fold. Eye cases bright red. Eye cases and head with scattered patches of pale orange setae. Ventral side of the abdomen with scattered orange setae occurring in distinct patches bordering the tongue case which is bright orange brown and detached for the length of the abdomen. The thoracic spiracles are conspicuous as bright orange red dashes. The cremaster is pale reddish brown with a darker edging, curved ventrally and bluntly rounded with a small bulge at each side and on the apex. It is covered with stiff reddish brown setae. Pupation occurs in a sealed case made from a leaf of the host plant which is cut loose and lies among the dried leaves at the base of the plants. The case is thinly lined with powdery silk. Pupation occurs two days after construction of the cocoon. Imagines emerge from ten to thirteen days later in the summer broods. The larvae produced by the third brood hibernate in the fourth instar.

ACKNOWLEDGEMENT

I would like to express my sincere thanks to WILLIAM H. HOWE, butterfly artist, for the illustrations of the life history in fig. 1.

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IDENTITY OF *HELIOSEA CELERIS* *MELICLEPTROIDES*

WITH NOTES ON ITS HABITS

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Davis, California

IN JUNE, 1963, a series of "*Helioseia celeris melicleptroides*" Benjamin (Noctuidae) was collected two miles north of Elephant Butte, Plumas County, California. These seven specimens are in fresh condition, having emerged very shortly before their capture. Five of the seven specimens were collected on *Eriogonum latifolium* var. *nudum* (Benth.) where they were feeding on the blossoms; the other two specimens were collected from inorganic objects. The peak of their flight seemed to be around 1:00 P.M., the temperature was in the low seventies, and the sky a bit overcast, thus making the capture of these ordinarily wary, rapid fliers quite easy.

In the original description of this subspecies, Benjamin (1935) admits the very close similarity of *melicleptroides* to nominate *celeris* (Grote). The original description reads: "Entirely similar to *celeris celeris* excepting that the ground color of the fore wing is olive fuscous, and the median band is conspicuously cream white creating the habitus of a *Melicleptria*, while the hind wing has much less of the deep red orange of the typical subspecies." At first this description was thought to be of a worn or faded specimen, as fresh specimens from the same area are certainly not fitting of this description.

Upon examination of the Holotype in the United States National Museum it was found that the type is equally as colorful in maculation as is *celeris celeris* in all respects. Comparison of the male genitalia in both the Sierran and the coast range populations also leads one to conclude consubspecificity. The type locality for *melicleptroides* is Keddie, Plumas County, California ("VI-20"), very near where the specimens under examination were collected.

Comparison of the Sierran population to those of the coast ranges proves the populations examined to be consubspecific in all respects, and the subspecific name *melicleptroides* is therefore sunk as a synonym of *celeris celeris*.

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LIVING PUPAE of Hyalophora gloveri, H. cecropia and A. polyphemus for sale. 25 cents each. Jim Oberfoell, Bowman, N. Dakota.

WANT living Cymothoe coccenata, M. H. Ross, Div. Cancer Embryology, Biochem. Research Foundation, Newark, Delaware.

WANT Papilio zelicaon living stock, females or pupae. Will pay for field work or stock. C. G. Oliver, Educational Services, Inc. 108 Water St., Watertown, Mass. 02172.

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THE JOURNAL OF RESEARCH ON THE LEPIDOPTERA

Volume 4

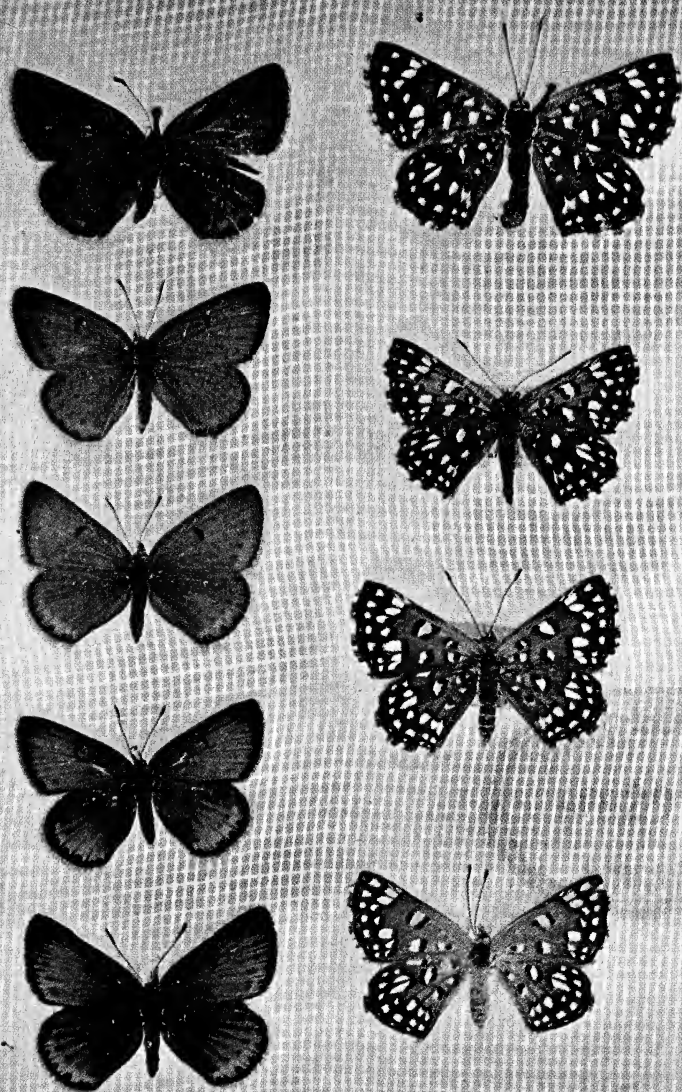
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THE PURPOSE OF THE JOURNAL is to combine in one source the work in this field for the aid of students of this group of insects in a way not at present available. THE JOURNAL will attempt to publish primarily only critical and complete papers of an analytical nature, though there will be a limited section devoted to shorter papers and notes. QUALITY WORK on any aspects of research on the Lepidoptera is invited. Analytical and well illustrated works are preferred, with a minimum of long description.

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DISTRIBUTION AND PATTERN OF VARIATION IN *PHILOTES RITA*

R. H. T. MATTONI

North American Aviation, Downey

PHILOTES RITA HAS USUALLY BEEN regarded as a distant taxon with a relatively restricted range in Southern Arizona (Comstock, 1953; Tilden and Downey, 1955). Mattoni (1954), however, in briefly describing the distribution of *P. rita* included "California everywhere east of Sierras" in the range as well. This statement was based on several specimens, genitally determined from several such localities (see below). Configuration of the male genitalia, principally the valve and aedeagus, has been recognized as the primary characteristic distinguishing *P. rita* from all other members of the genus (Barnes and McDunnough, 1916a; Watson and Comstock, 1920; Mattoni, 1964; and Tilden and Downey, 1955). Tilden and Downey (1955) described as a new species *P. pallescens*, which they clearly recognize as closely related to *P. rita* on the basis of the male genitalia. Because of proportional differences in the shape of the valves and other features of the genitalia, principally the presence of a sclerotized protuberance on the valves, in addition to highly disparate appearance of the alar characters, these authors regarded *P. pallescens* as a distinct species. Tilden (personal communication) indicated, however, that this conclusion was by no means rigorous and was based largely on the lack of data on intermediate populations. Perhaps the most significant biological feature of this species is its flight time, which is virtually always in the late summer from mid-August through September. All recorded observations of foodplant preference shows *P. rita* to be associated with the low woody perennial Fall Blooming *Eriogonums*: *E. wrightii*, *E. effusum*, and *E. plumatella*.

Further data to be presented in this report show that *P. rita* is, in fact, a widespread species and that *pallescens* is most reasonably regarded as one of several subspecies of which two new subspecies are described herein.

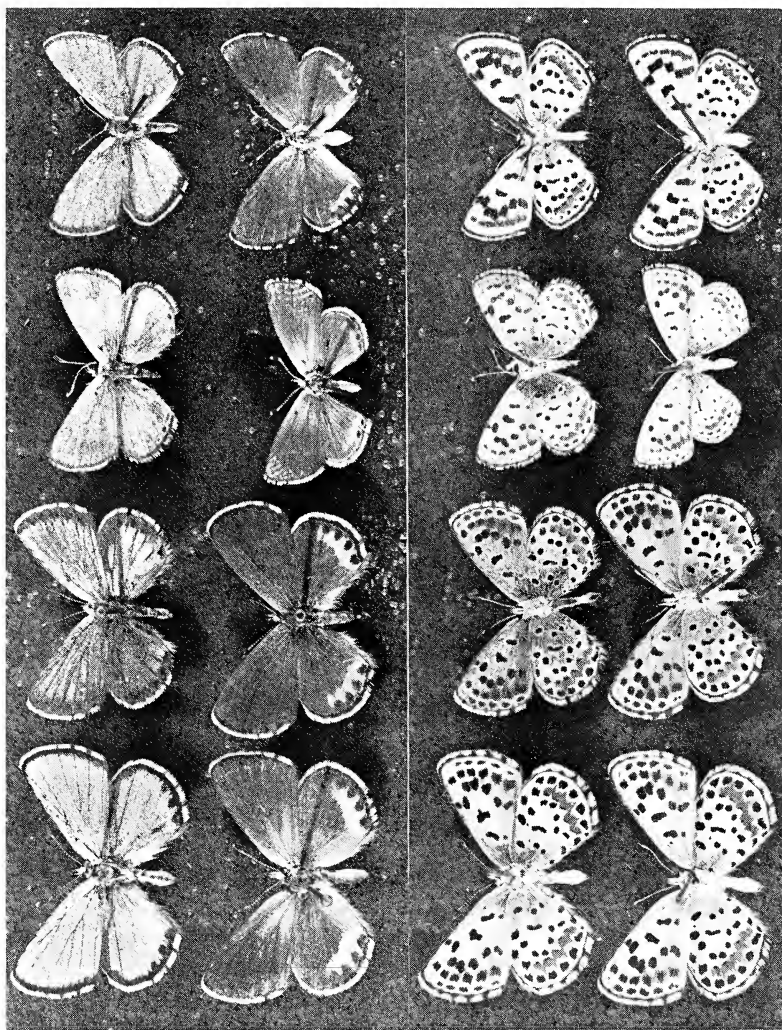


Fig. 1. Representative specimens of *P. rita* subspecies. Each column represents uppersides and undersides of males and females of each. Column 1, *P. rita rita*. Ramsey Canyon, Cochise Co., Arizona, September 1, 1953, Coll. L. Martin. Column 2, *P. rita coloradensis*. Holotype and allotype, data in text. Column 3, *P. rita pallescens*. Paratype, Little Granite Mt. Tooele Co., Utah. Male August 16, 1954 (Coll. Eastin), Female August 20, 1953 (Coll. Cott). Column 4, *P. rita elvira*. Holotype and allotype. Data in text. All specimens in Los Angeles County Museum collection.

In the following paper wing dimensions are given as length measured from base of CU to terminus at M_2 . The nomenclature used incorporates part of the Nabokov terminology (1944) and classical usage.

Philotes rita rita

Barnes & McDunnough 1916. Can. Ent. 48:233.

Characterization and Variation: (fig. 1)

The authors of this species figure the types [(1916b) Plate XI, Figures 3 & 6] and male genitalia [(1917) Plate XVII, Figures 5 & 7.] Specimens are also illustrated in Comstock (1927) Plate 56 Figures 4, 5, and 6, and Holland (1931) Plate LXVI, Figures 39 and 40 (paratypes).

The characters upon which the specific differentiation of this species was based include for the males: creamy white underside, narrow (1 mm) upper side marginal band, and the aurora showing on the upperside secondaries. In both sexes characteristics included large size wingspread (23 mm=11.5 mm length), the very broad and extensive development of the aurora on the underside, and the large and distinct macules. Table 1 includes a study of variation of several characteristics of *rita* and other subspecies.

The specimens from which this table was prepared were all collected at Ramsey Canyon, Arizona and are in the Los Angeles County Museum. The data given include number of species examined, range in forewing spread in males and females, etc. The columns indicate the parameters, and the rows indicate the data obtained for each named form. The most noteworthy features of general appearance include the high frequency of males with an upperside aurora, large size, and clear underside maculation with faint halos.

Genitalia:

The authors of this species based its distinctness on the conformation of the male genitalia. They noted relationship to *P. enoptes*, yet called attention to the greater length of the claspers (valves). In fact, gross inspection indicates the entire genitalia are distinct, including all aspects of the tegula and vinculum, gnathos, and aedeagus. Watson and Comstock (1920) noted the broad lobed base of the aedeagus as quite distinct from that of *P. enoptes*. The male genitalia of each subspecies considered here appear to be distinct, although they all clearly conform to the general *P. rita* characteristics. The genitalia are also subject to considerable variation, even on the basis of the small numbers

Table 1

Pattern of Variation and Variability in Samples Available
Including Type Series of P. rita elvirae and P. rita coloradensis.

<u>MALES</u>	Number Examined	Forewing Spread (mm)	Upside Cyanic Overlay	Frequency With Aurora	Terminal Line Width (mm)	Secondary Sub- marginal Macules-Number
Rita	59	10.5-13.1	blue	.83	.6-.9	3-6
Pallescens	14(1)	(9.9)	lt. grey blue	.07	(.3)	3-6
Coloradensis	31	9.9-12.5	Purplish Dk. blue	.97	1.0-1.6	(A)
Elvirae	36	9.4-11.5	lt. grey blue	0	.4-.6	0-4

<u>FEMALES</u>	Number Examined	Forewing Spread	Upside Frequency Basal Grey Sealing	Aurora
Rita	50	10.5-12.9	.66	Prominent .20 - .30 wing width at CU ₂
Pallescens	10(1)	(9.6)	1.00	Diminished .05 wing width at CU ₂
Coloradensis	26	9.8-12.6	0	Prominent .25 - .30 wing width at CU ₂
Elvirae	46	8.7-10.6	0	Diminished .05 - .20 wing width at CU ₂

Table 1. (Continued)

BOTH SEXES UNDERSIDE	M ₁ Secondary Inflation	Ground	Halo	Frequency With- out Secondaries A2 Basal Macule	Primary Sub- marginal Macules	Shape Basal-Diam. Macules Primary	Frequency With- out R2 Post- Median Macule Primary	Frequency Marginal Macules- Primary				
								0	3	4	5	6
Rita	None	Very lt. grey white	Faint	.04	6	Sub- Circular	.06	0	0	.10	.72	.18
Pallesceus	None	Off- white	None	No data but variable	5-6	Sub- Circular	No data but variable	0 or 4-minute				
Coloradensis	Present	lt. grey	Distinct	.09	6	Sub- Circular	.32	0	0	.40	.39	.21
Elvirae	None	Off- white	None	.35	6	Strongly Sub- quadrate	.04	.15	.07	.55	.23	0

(A) Band usually not dissociated

() For P. rita pallescens gives data for available paratypes only. Other data from Tilden and Downey 1955.

of specimens examined. Tilden and Downey (1955) noted that the two examples from the type series illustrated by Barnes and McDunnough (1917) actually "appeared to be of two species." They refer to Figure 5 (Plate XVII) resembling *rita* and Figure 7 resembling *pallescens*.

In spite of variability, the features unique to *P. rita rita* include the conformation of the valves, which distally widen laterally gradually and form an obtuse angle, by the much reduced crista, and by the usual presence of a spiny protuberance on the distal dorso-medial portion (Tilden and Downey, 1955). The aedeagus is also distinct in that the lobes are nearly opposite, almost forming right angles to the shaft. In the small series prepared, the size of the proximal protuberance of the crista varied from barely to markedly distinct.

The female genitalia are also quite distinct from the *P. enoptes* group, particularly in the configuration of the vaginal lamellae which form the ostium bursae. The structure in *P. enoptes* is heavy complex subquadrate structure (Mattoni, 1954). Figures 2 to 5 show both lateral and ventral aspects of the vaginal lamellae for representatives of all sub-species of *P. rita*. Certain variations among the different subspecies are apparent from these photographs. However, from the limited number of preparations examined, the variation within a sample appears as great as differences between selected individuals of the different named forms. Variation encompasses the shape of the distal portion, varying from pointed to round, the shape and sclerotization of the ventral borders of the ostium, and the lateral shape, varying from a virtually straight to a slightly "s" form.

Distribution and Habitats:

Arizona: Types, 3 ♂ and 3 ♀ So. Arizona (Poling),

1 ♂ Santa Rita Mts., Pima Co., Arizona

1 ♂ Rio Verde Mts., Arizona

Other Records:

Ramsey Canyon, Huachuca Mts., Cochise Co., Arizona.

IX/1/53 (et seq.) (Martin, Comstock, Ford, and Thorne)

Humboldt, Yavapai Co., Arizona VIII/19/53 (Tilden)

One of the cited type localities, Rio Verde Mountains, cannot be located on existing maps. It is believed that this is the old name for the Huachuca Mountains, hence permitting the Ramsey Canyon material to be regarded as topotypical. The distribution map of this and other subspecies is given as Figure 6.



Fig. 2. Male and female genitalia. *Philotes rita rita*. A. Male Ventral, B. Male Lateral, C. Aedeagus, D. Male Ventral—note variation in valve armature, E. Female Ventral, F. Female Lateral. All from Ramsey Canyon, Huachuca Mts., Arizona.

Comstock (1953) described the habitat of *P. rita* in Ramsey Canyon as the foot of the canyon in open country suitable for grazing, although not overgrazed. The foodplant, a low perennial, was identified as close to *Erigonum wrightii*. Comstock describes a single egg which was taken by watching an ovipositing female. The egg was deposited among the flowers.

***Philotes rita coloradensis*,**

new subspecies:

Holotype Male: Forewing 10.6 mm; width: 6.9 mm;
 Hindwing 8.5 mm; width: 6.7 mm.

Upperside both wings with dark purplish blue cyanic overlay, slightly darker than typical *rita*. Terminal fuscous band 1 mm wide at M_2 on both wings. (On secondaries terminal band is discontinuous in A 1, CU_1 and CU_2). Slight pink aurora in A 1 and CU_2 more pronounced in A 1. Terminal fringe white, interrupted by infuscation at veins CU_1 and CU_2 on primaries, and continuous fuscous basal from A 1, both wings. Anterior infuscation complete in R and extending over distal half of R_2 .

Underside ground light grey with slight melanic suffusion, macules strongly differentiated from ground by off-white halo. Faint blue cyanic overlay. Macule pattern shown in Figure 1. Aurora extending from M_1 to A 1, on secondary subquadrate in M_1 and A 1, cusped in other interneural spaces. Faint macule distal to each. Terminal lines less than .1 mm wide, with fuscous coastal scales extending $\frac{1}{2}$ distance of fringe. (Infuscation of vein termini as shown in the figure.)

Allotype Female: Forewing: 11.5 mm; width: 7.6 mm;
 Hindwing: 8.8 mm; width: 6.9 mm.

Upperside of both wings brown, slightly lighter in basal third. Faint blue grey scaling in basal 1.5 mm. of wings. Overlay of faint orange green. Secondaries with pronounced orange aurora extending from posterior $\frac{1}{3}$ of M_2 through A 1. Faint light scaling between distal aurora and terminal line. Prominent round brown macules isolated between aurora and terminal line from M_2 to A 1. Terminal fringes white, interrupted by fuscous in A 1 and CU_2 on both primaries and secondaries.

Underside ground very light brown. Slight fuscous suffusion evident only in M_3 , CU_1 , and CU_2 of the forewing. Faint halo surrounding macules. Macule pattern shown in Figure 2. Aurora well developed, extending from RS to A 1. RS auroral element very small, subquadrate, remainder as in male. Terminal line less

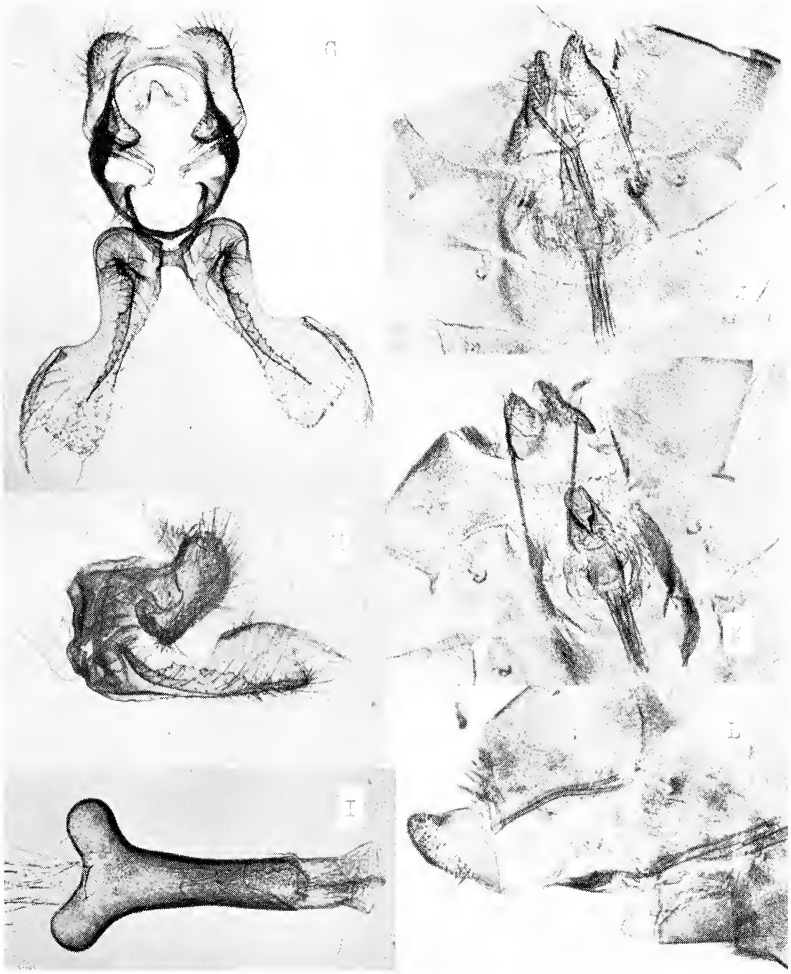


Fig. 3. Male and female genitalia. *P. rita coloradensis*—G. Male Ventral Paratype No. 7, H. Male Lateral Paratype No. 10, I. Male Aedeagus Paratype No. 7, J. Female Ventral Paratype No. 33, K. Female Ventral Paratype No. 31—note configuration of lamellae vaginalis, L. Female Lateral Paratype No. 32.

than .1 mm wide, costal scales $\frac{1}{2}$ width at fringe. Infuscation of vein terminals as shown in the figure.

Types:

Holotype Male; allotype female and 30 male and 25 female paratypes miles south Kendrick, Lincoln County, Colorado, August 21, 1964. R.H.T. Mattoni. Holotype, allotype and 3 pairs of paratypes in copula. Illustrated in Figure 1. The subspecies is named after the state of its presently known distribution.

Characterization and Variation:

The pattern of variation of the type series is given in Table 1. In general the subspecies is rather similar to typical *P. rita*. *P. rita coloradensis* may be clearly distinguished by the male cyanic overlay, which is purplish blue, and wide terminal line. In both sexes the darker greyish underside ground and clear halos are discriminating. Otherwise the females are indistinguishable. A significantly different frequency distribution of number of marginal underside primary macules and absence of the R-2 post-median marginal macule are noteworthy. Figure 7 shows the range of intensity of underside macules in a series of four males and females each of this subspecies (Upper 2 rows).

Genitalia:

The male genitalia are clearly similar to *rita*. The dorsal margin of the valves, however, recurve at a somewhat more acute angle. The cristae are quite pronounced, as are their proximal protuberances (based on only 4 preparations.) The dorso-median spiny protuberance is not present. The aedeagus is somewhat more definitely bifurcate than in *rita*, although less so than the following two subspecies. The tegumen and vinculum, particularly in lateral aspect, are not so massive as in typical *rita*. The female genitalia have been commented upon above. Genitalia of both sexes are illustrated in Figure 3.

Distribution and Habitat:

The clue which led to the collection of the type series was the cited publication, in Brown's *Butterflies of Colorado*, of a *Philotes* taken in late August on in the prairie. The date strongly suggested *P. rita*, the peculiar ecological site suggested an interesting population. Correspondence with Bernard Rotger provided the precise locality of specimens, cited in Browns book, from which the type series was taken. This locality is in the gently rolling prairie grassland which extends west towards the Rockies, and to the north, south, and east. Other localities cited included

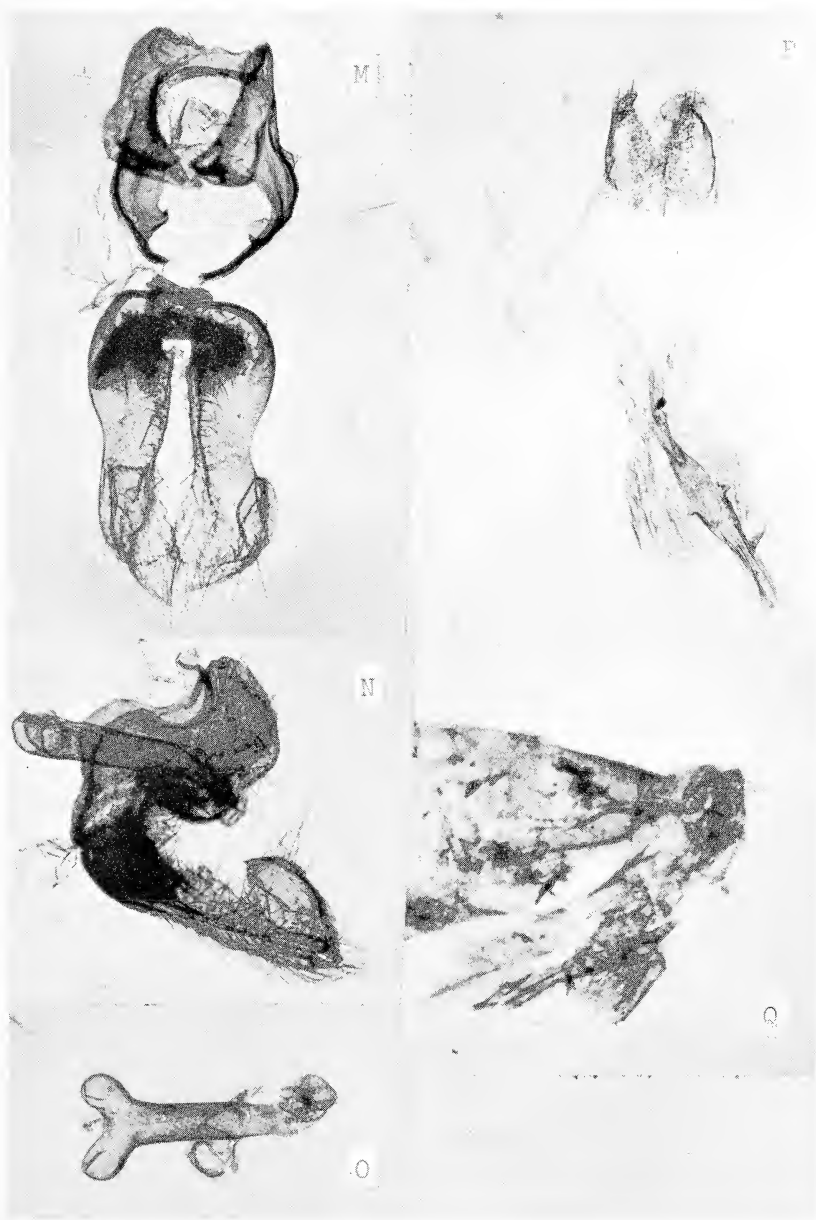


Fig. 4. Male and female genitalia, *P. rita pallescens*—M. Male Ventral, N. Male Lateral, O. Male Aedeagus, P. Female Ventral, Q. Female Lateral—Paratypes L.A. Museum.

Aroya, Cheyenne County; VIII, 24, 1934 (P. S. Remington); Bristol (Verhoeff), Hartman (Marston), and Holly (Lotrich) all in Prowers County. None of these specimens were examined, although they probably belong to this subspecies. After taking the type series, systematic collecting in cuts along highway 94 west of the type locality indicated *coloradensis* occurs at least to within 15 miles of Colorado Springs in El Paso County. The butterfly was most abundant around dense stands of the foodplant at the latter site, which was the edge of a steep rise, sloping down to the west. This was 6.7 miles east of the junction of highways 24 and 94. Assuming these samples to all represent *coloradensis*, the distribution is given in Figure 3.

The populations were apparently aggregated where the foodplant was dense. The best micro-habitats were road cuts and along the roads on the shoulders where fencing reduced grazing activity. The type series was taken in the middle of a pasture, however, where the foodplants were distributed both along the rises and in the swales in the gently rolling terrain. At the time of collecting, *Philotes* were virtually the only butterflies out.

There is no question but that the subspecies is more widely distributed than the data indicate, probably ranging east into Kansas, north into Nebraska, and south into New Mexico. It would not be surprising that in some of these areas distinct populations are yet to be found. This is a subject open to inquiry by collectors willing to explore at the proper time of the year. Such collecting would not be profitable for taking other than *P. rita*, however.

The foodplant, *Eriogonum effusum*, was confirmed by observing oviposition in the field. Two eggs were in fact collected. In both cases the eggs were deposited deep inside individual flowers, where they were concealed at the base of the anthers. No other *Eriogonum* was observed in bloom at the locality. It would repay collectors of *Philotes* to observe females for ten minutes or so to confirm foodplant identity. In this way exact foodplant records would be available for future correlation. There appear to be important foodplant specificities which deserve further study (Langston, 1964; Mattoni unpublished). David Verity identified the foodplant from plant fragments preserved with the eggs.

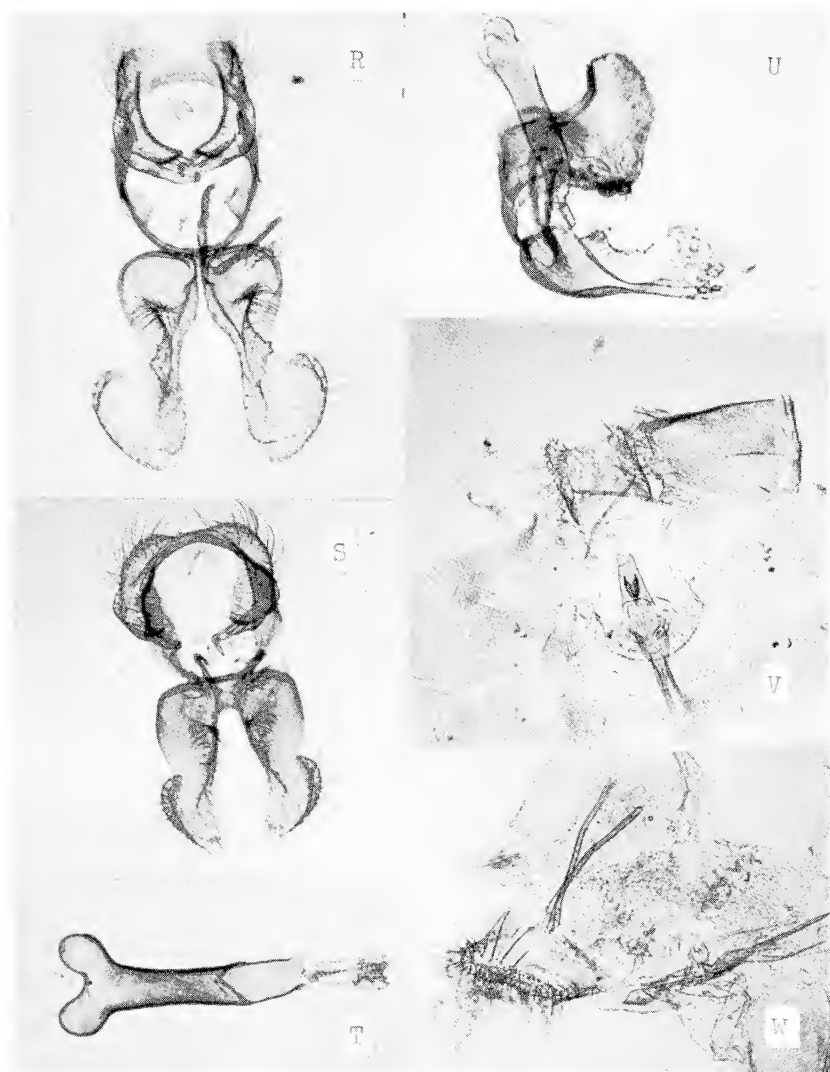


Fig. 5. Male and female genitalia, *P. rita elvirae*—R. Male Ventral—Paratype 15, S. Male Ventral—Paratype 17—note armature of valve, T. Male Aedeagus—Paratype 18, U. Male Lateral—Paratype 16, V. Female Ventral—Paratype 37,, W. Female Lateral—Paratype 33.

P. rita pallescens:

Tilden and Downey, 1955, *Bull. So. Calif. Acad. Sci.* 54:25-29.

Description and Variation:

Since only a pair of paratypes were available for this discussion, (Figure 1) comments on variations must paraphrase the detailed comments of the original authors. They noted particular variation in the number of submarginal macules on the outer margin of the male upperside secondary, which range from 3 to 6, and in the amount of grey overlay in the basal female primary. Other maculation variation was noted. The pertinent data are summarized in Table 1.

Type specimens are figured in the original description, along with specimens of *P. rita rita* for comparative purposes.

Genitalia:

Figure 4 illustrates the male and female genitalia for the pair of paratypes available. Further drawings and detailed descriptions of the male are given in the original description. In general, the shape of the valves clearly distinguish *pallescens* from the previous two subspecies, but show similarity to *elvira*. Further differences can be seen in the shape of the tegumen and vinculum, particularly in lateral aspect. The strongly bifurcate aedeagus is another differential feature. The female genitalia are figured and have been commented upon above.

Distribution and Habitat:

The only specimens known at present are the type series cited by Tilden and Downey (1955). These were taken in mid-August in the Stansbury Mountains, Little Granite Mountain, Tooele County, Utah, around *Eriogonum* sp.

Philotes rita elvira**New Subspecies:**

Holotype male:: Forewing: 10.5 mm; width: 6.5 mm;
Hindwing: 8.0 mm; width: 6.2 mm.

Upperside both wings with blue cyanic overlay, lighter than typical *rita*, similar to *pallescens*. Light grey ground filling A 2 of secondaries. Marginal band relatively narrow, about .4 mm both primaries and secondaries at M₃. Trace of submarginal macules in A 1 and CU₂ of secondaries. Marginal fringe white, with infuscation at vein termini CU₂ and continuous fuscous fringe on inner margins basad from A 1, both wings.

Shape of secondary distinct, outer margin from anal angle to M₁ forming very shallow curve, compared with all other *Philotes* which are strongly curved.

Underside ground light cream grey, macules set in ground without halos. Primaries: Discoidal and post median macules strongly subquadrate and prominent, wholly filling the interneural spaces. Semi-macules subquadrate, increasing in width caudally, filling entire interspaces to give appearance of a continuous line with gap only at M_1 . Submarginal macules faint. Secondaries: Macules subcircular, pronounced. Aurora extending as a solid band from A 1 to M_1 . Cusps indistinct. Fringes as above. Terminal lines prominent, about .2 mm wide.

Abdomen—very light grey under and lateral with melanic scaling above.

Allotype female: forewing: 10.9 mm; width: 6.5 mm;
 hindwing: 7.6 mm; width: 6.0 mm.

Upperside: Ground dark brown, lighter scaling in A 2 secondaries. Faint cyanic overlay in basal 1/10 of wings. Fringes white with infuscations at vein termini extending from A 1 to M_3 , continuous, cusped. Cusps formed by row of submarginal macules in same interneural space.

Underside: Ground cream white, maculation as male, except macules larger and aurora strongly cusped. Marginal fringes infuscated at vein ends A 1 to CU_1 both wings.

Abdomen: Cream white over all but extreme upper surface, latter dark brown.

Types: Holotype male and allotype female 3.5 miles southwest of Pearblossom, L.A. Co., California. Holotype, August 20, 1964, Allotype, August 24, 1963. 36 males and 46 female paratypes, same locality August to October, 1963 to 1965.

This subspecies is named in memorial to my late mother, Elvira "Toni" Mattoni, whose encouragement and help in developing my interest in biology were primarily responsible for efforts as encompassed in this work.

Characterization and Variation:

The pattern of variation of the type series is given in Table 1. In general this subspecies is superficially similar to *pallescens* and extremely unlike either *rita* or *coloradensis*. The most striking feature is the secondary wing shape showing maximum expanse at M_1 rather than M_2 and a rather straight outer margin. This is illustrated both in Figures 1 and 7. Other unique features include the wide underside marginal band and strongly subquadrate macules. The extreme variation in the intensity of underside maculation is shown for a selected group of four males and five

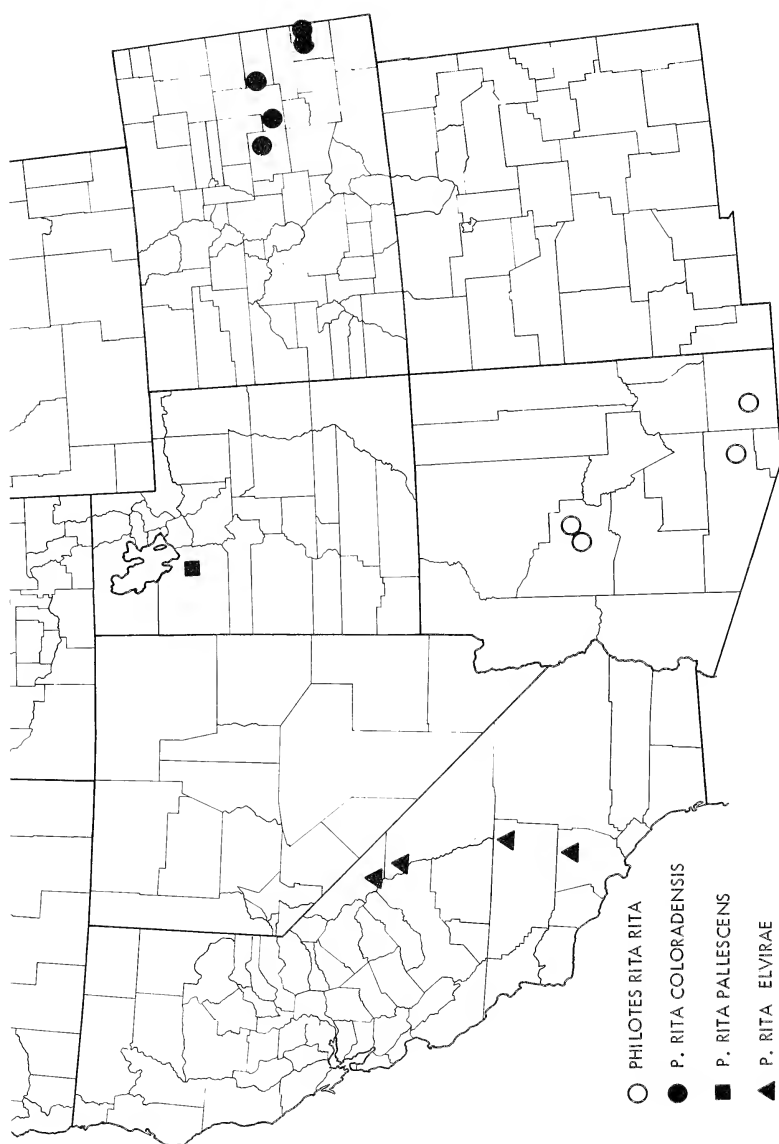


Fig. 6. Map showing the distribution of *Philotes rita* subspecies.

females in Figure 7. The last female is clearly aberrant on the primaries, an effect probably imparted by environmental shock during pigment deposition in the early pupal stage.

From Table 1, certain features of the pattern of variation stand out. These include the absence of males with an upperside secondary aurora, the frequency distribution of primary marginal macules, and the high frequency lacking the A 2 basal macule.

Genitalia:

The male genitalia, illustrated in Figure 5, shows a close similarity to *pallescens*. In five of the six preparations examined, the crista of the valve is pronounced with a well developed proximal protuberance. The latter, however, occurs about one third of the length from the basal or valve attachment. In the preparation of paratype no. 17, both crista and the protuberance are not clear. The aedeagus is deeply bifurcate. The tegumen and vinculum in lateral aspect appear somewhat more compressed than in the other subspecies. The female genitalia, illustrated in Figure 5 have been commented on above.

Distribution and Habitat:

The subspecies was first recognized as a *P. rita* variant in several isolated specimens taken at Mammoth Camp, July (F. W. Friday); Walker Pass Summit, Kern Co., September (C. I. Smith); and Little Rock, L.A. Co.; September (Unk.) The specimens were in my collection, which was destroyed by fire. They had all been genitally determined, but the records were based on recollection. They did serve as the basis for the distribution statement I gave for *P. rita* in California (1954). I further recollect that the Friday specimen was in a series of *P. battoides glaucon* collected the same day. From other records of this species collected at Mammoth, *elvira* might be expected to occur in the lower Ponderosa forest at about 6100 ft., probably near the old post office. There is, in addition, a single male taken "above Bishop," Inyo Co., (July 10, 1928, L. Martin), in the Los Angeles County Museum.

The type series was collected by Chris Henne in a desert wash about 3.5 miles southwest of Pearblossom, L.A. County, California. These were found flying from late August through mid-October, depending on seasonal conditions. Mr. Henne notes they are strong fliers, difficult to follow on warm days. Chris Henne has found the females ovipositing on the flowers of *Eriogonum plumatella*. He will shortly formally describe the life

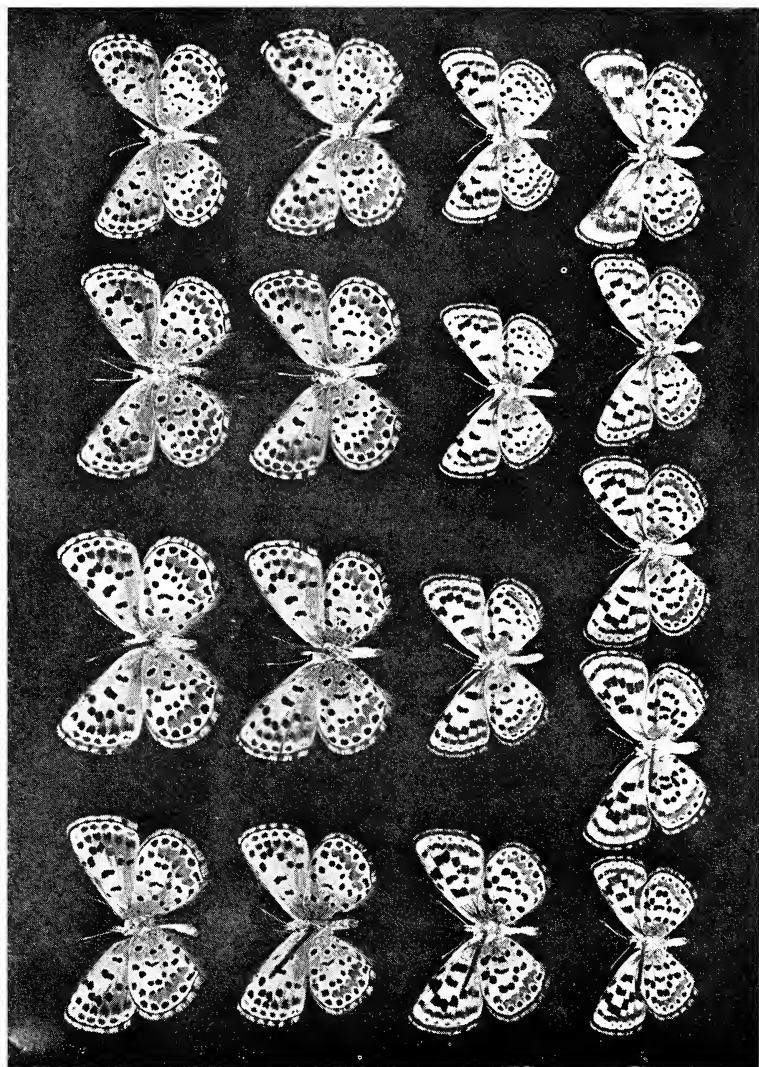


Fig. 7. Variations in underside maculation. First row: *P. rita coloradensis* males, Paratypes No. 4, 3, 2, 1. Second row: *P. rita coloradensis* female, Paratypes No. 34, 35, 36, 37. Third row: *P. rita elvira* female, Paratypes No. 1, 2, 3, 4. Fourth row: *P. rita elvira* females, Paratypes No. 22, 23, 24, 25, 27.

history in detail. *E. phumatella* is a fall blossoming low perennial member of the genus, closely allied to *E. wrightii* and *E. effusum*.
Type Distribution:

Holotypes, allotypes, and paratypes are deposited in the L.A. County Museum except for 1 pair of paratypes each to the California Academy of Sciences, and the U.S. National Museum. All genitalia preparations are in the L.A. county museum.

Discussion and Diagnosis:

The taxonomic conclusion of placing the four taxa described above as subspecies is based in my opinion that greater biological meaning arises from a classification based upon relationship rather than difference. Because of certain distinct features of these subspecies, particularly with reference to the male genitalic configuration, one could plausibly argue specificity. Such arguments would have dubious biological significance—as the real issue of this dissertation is a description of the patterns and modes of variation of a limited number of phenotypes sampled. I believe it is possible to recognize a collection of morphological and ecological relationships which do define an entity we may conveniently refer to as *Philotes rita*. The entity is morphologically defined by the configuration of both the male and the female genitalia; and ecologically defined both by the adult flight time in the late summer to early fall and association with a group of low woody perennial *Eriogonum*.

Within this entity or species, I have defined four modal groups, two previously described and two previously undescribed. According to characteristics evaluated above, these four entities or subspecies may be discriminated by a combination of characteristics abstracted from Table 1. One may immediately differentiate *rita* and *coloradensis* from *pallascens* and *elvirae* by the latter exhibiting a very light, off-white underside ground color without halos, their usually somewhat smaller size, the faint terminal line and the general absence of aurora in the male upperside, and by the greatly reduced aurora on the female upperside. *P. rita* and *coloradensis* are somewhat similar. In both sexes they may be distinguished by the underside characters only. The ground of *rita* is lighter, producing fainter halos to demark the macules. There is no evidence of infuscation in the anal area of the underside primaries in *rita*; whereas the infuscation is rather pronounced in all specimen of *coloradensis*. The females differ primarily in the high frequency of individuals possessing basal grey scaling in *rita* which is totally absent in the sample I have of *coloradensis*. The males may be furthermore discrim-

inated genitally by a number of characters of the valves, aedeagus, tegumen and the vinculum. To differentiate *pallascens* from *elvira* only an instant's inspection of the underside is necessary. The former possesses very small subcircular macules, the latter large strongly developed subquadrate macules. *P. elvira* also possesses a peculiar wing-shape of the secondaries, unique among all of the *Philotes*. Both samples may be furthermore differentiated by the male genitalia which differ in the configuration of the valves, aedeagus, tegumen and vinculum. The female genitalia of all four subspecies appear to be sufficiently variable among samples that differentiation by this character is not practical.

Except in the case cited above for *P. rita elvira* in the Sierra, there is no evidence of ecological sympatry among the forms of *rita* and those of any of the other members of the genus. There is, however, a considerable amount of geographical overlap.

The species is far more widespread than was previously noted. One of the most interesting features of *P. rita* is its distribution to the south and the east which place it clearly beyond the boundaries of any of the other *Philotes*. The southerly range may, however, be an artifact of poor collecting as certain members of the *P. battoides* group may be found well into Mexico. The easterly range is surely unique as intensive summer collecting should have revealed either *P. enoptes* or *battoides*. Further distributional data will be quite revealing and should be sought after by collectors in appropriate areas working at otherwise unrewarding fall collecting.

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THREE CASES OF GYNANDROMORPHISM IN GONEPTERYX:

AN OBSERVATION WITH ULTRAVIOLET RAYS

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WHILE REVISING THE GONEPTERYX cabinet in the Lepidoptera Collection at the Zoological Museum, Kiev Shevchenko State University, I found three gynandromorphic specimens of *Gonepteryx*: two of *G. rhamni* L. and one of *G. cleopatra* L., species that have been photographed with UV-light using the method described previously (Nekrutenko, 1964). Results of this observation seem to be interesting enough to publish them here together with brief remarks.

The phenomenon of gynandromorphism is well known among the Lepidoptera, but it occurs in various groups with different frequency. Anomalies of embryogenesis during the very initial stages results in various parts of the insect's body that are marked with characters of different sex. In some cases the body of an insect seems to be formed from two halves, one bearing characteristics of, say, female — the other one, of male (bilateral gynandromorphism). In other cases characters of different sex are mosaically distributed on the ground of normal tissues of the specimen (mosaic gynandromorphism).

A. A. Jachontov (1935) explains the cause of gynandromorphism by the abnormal division of nuclear substance in the division of the fertilized egg; if this takes place at the very first division, a bilateral gynandromorph arises. If such an anomaly occurs at the later stages of the egg division, the gynandromorph will be a mosaic. S. A. Hessell (1964) noted that a bilateral gynandromorph may arise as a result of "a binucleate ovum or by the loss somehow of an X chromosome in the very first cell division". It is interesting to note that both *G. rhamni* and *G. cleopatra* are mentioned by Schultz (1904) as a species with high frequency of gynandromorphic aberrations. From a total of 1074 gynandromorphs known to him, 45 are of *G. rhamni* and 41 of *G. cleopatra* (cited by A. A. Jachontov, 1935).

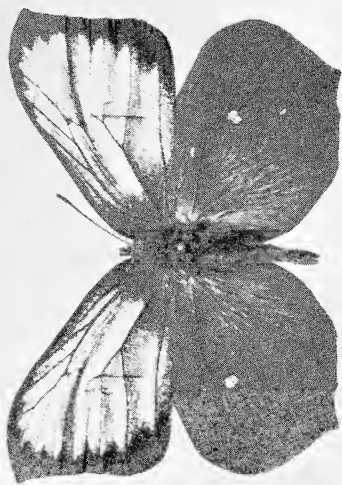
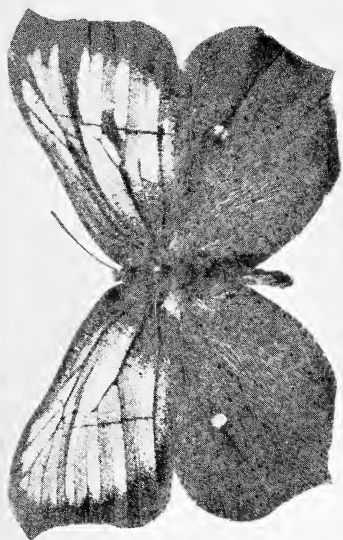


Fig. 1. *Gonepteryx rhamni* L., normal ♂; Fig. 2. *G. rhamni* L., normal ♀.
 Fig. 3. *G. rhamni* L., ♂ gynandromorph. Wien, Coll. L. Sheljuzhko.
 Fig. 4. *G. rhamni* L., ♀ gynandromorph. Kiev, 13.V.05, Weidinger leg.
 Coll. L. Sheljuzhko.

GYNANDROMORPHISM IN *Gonepteryx rhamni* L.

In visible light the sexual dimorphism, or, more precisely, *dichroism* (a term proposed by G. A. Mazokhin-Porshnyakov, 1957) is expressed in the fact that the wings of the male are smooth yellow, with small orange points in the transverse veins of both fore and hindwings. The coloration of the female is also smooth, but green-yellowish.

In ultra-violet light the sexual dichroism can be seen in the male by the presence of a hidden wing-pattern, while the female appears smoothly dark (see Figures 1, 2).

The optical nature of the hidden wing-pattern in *G. rhamni* will produce the "gynandromorphic effect" when the subject and the source of light are arranged so that the bright central field of one side will absorb ultra-violet rays (Nekrutenko, 1965).

One of the two specimens under consideration (Wien, Coll. L. Sheljuzhko) is a male in which some stripes of female color can be traced in the right forewing. Under ultra-violet light it is easily seen that these stripes have the dark color of the entire surface of a female wing, highly contrasting on the ground color of the male's hidden pattern (see Figure 3).

Another specimen (Kiew, 13.V.05, Weidinger leg., Coll. L. Sheljuzhko) is a female with areas of male color in the right forewing (between the medial line of cell M_3-C_1 and dorsum) and in the foremost part of the hindwing. In the ultra-violet picture, this gynandromorphism is visible on the fore wing only, since the color of the hindwing in female and male is the same (see Figure 4). It is interesting to note that in the area of male color, in the uv picture, all elements of the hidden pattern are visible: the *zona opaca marginalis* and the *linea opaca medialis* on the ground of the bright central field. It is especially interesting to note the fact that gynandromorphism is expressed here not only by a color aberration, but also by an aberration of structure.

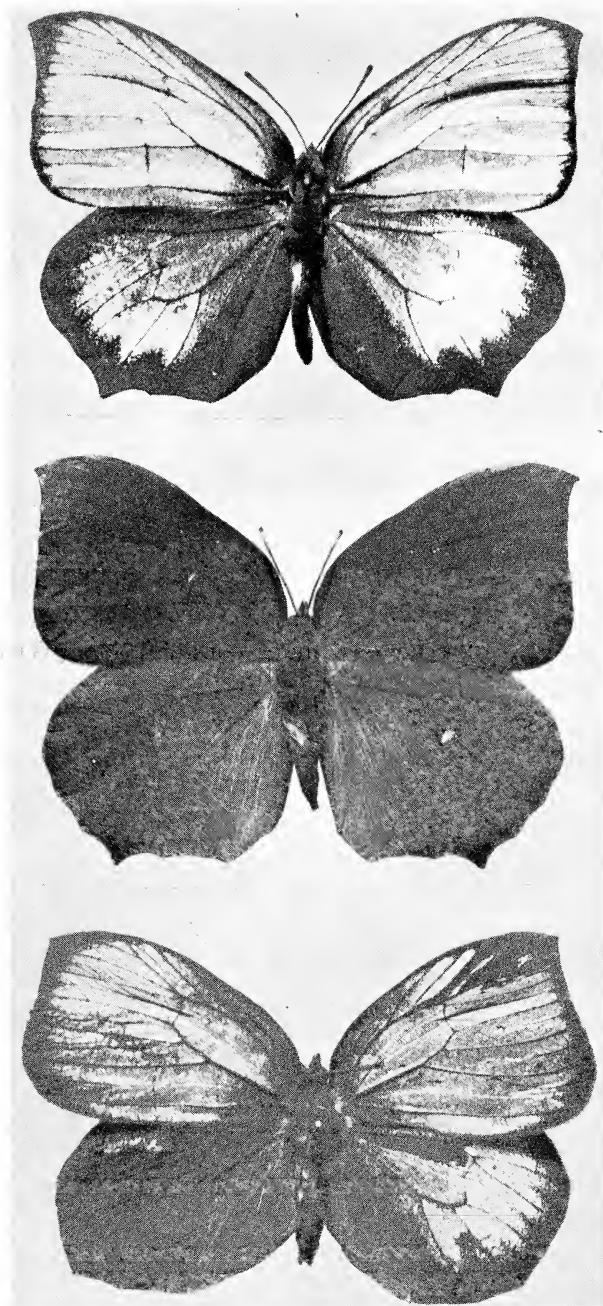


Fig. 5. *Gonepteryx cleopatra* L., normal ♂. Fig. 6. *G. cleopatra* L., normal ♀. Fig. 7. *G. cleopatra* L., monstrous gyandromorph. Dalmatia, Coll. L. Sheljuzhko.

GYNANDROMORPHISM IN *Gonepteryx cleopatra* L.

In this species, the sexual dichroism is seen in the male as a large orange spot in the upper surface of the forewing, while the rest of the surface is occupied by yellow *rhamni*-like color. The female is much like *rhamni* but the color is warmer, creamy yellow.

In ultra-violet light, the male has a narrow *zona opaca marginalis*, the same shape as the above orange spot. On the hindwing, the *macula lucida centralis* is very large and could be called *area lucida centralis alis posteriori*. The female is dark, as in *rhamni*. See Fig. 5 and 6.

Another specimen, marked in the label as a male, is a monstrous butterfly. The label determination is: *dalmatica* Vty. (= *italica* Gerh.) ab. (gynandromorph). From *Dalmatia* (Coll. L. Sheljuzhko). The right forewing in both visible and uv-light bears strips of female color. The left forewing is colored as a normal male. The right hindwing has a large central bright spot on the ground, in which dark stripes of female color can be seen in visible light. The left hindwing is dark in ultra-violet and of female color in visible light.

All three cases described are mosaic gynandromorphs. In spite of the fact that no examples of bilateral ones are available, the author believes that should a bilateral gynandromorph be found, it will appear as he described in 1965.

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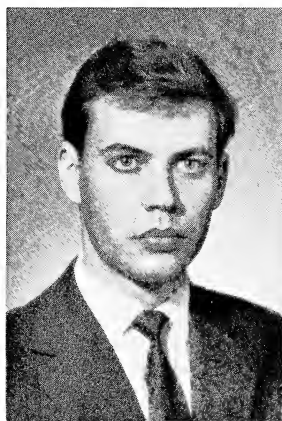
Born: Kiev, Ukraine. April 30, 1936

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Graduate student: Kiev State University, Biological Faculty

Position: Research assistant, Institute of Geology, Academy of Sciences of the Ukrainian S. S. R.

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AN ANNOTATED LIST OF BUTTERFLIES
FOR NORTHWESTERN OHIOJAMES W. PORTER
162 Hampden Park, Tiffin, Ohio

FOR THE PRECEDING EIGHT YEARS (1956-1964) the author has conducted full summer studies on the lepidoptera of northwestern Ohio, specifically on Seneca County (a similar list for moths has been compiled and its records are now being checked). The area studied is located about 50 miles south of Toledo, Ohio, and is part of the Lake Plains region drained by the Sandusky River (Fig. 1). Seneca County is approximately eleven percent woodland, in which scrub oak, hickory, and poplar are prominent, the large elm population having been excluded rapidly over the last five years by the Dutch elm disease. The remaining area consists of grassland and farmland (Fig. 2). Morphometric data (Fouzt, unpublished) for this area is: monthly rainfall, 3.03 inches—incidentally, no monthly rainfall average is more than .64 inches from this figure. The average temperature for December, January, and February is 28.73°F; for March, April, and May, 48.55°F; for June, July, and August, 71.35°F; and for September, October, and November, 53.35°F. The extreme high temperature recorded is 106°F in 1934; the extreme low for this area is -18°F, recorded in 1917. The frost free period ranges from May 1-7 to September 23-30.

Each species noted in this list, with the exception of *Speyeria idalia* and *Limentis arthemis arthemis* are capture records, the above two being sight records only. Two other local collectors in Seneca County were Mr. Frank Hepp, who made his collection prior to 1921, and Dr. Rhodes of Heidelberg College, Tiffin, Ohio, who maintained his collection until 1930. Most of their field notes are gone, so only their names could be listed if the species were contained in their collections (between the two collections a fairly thorough coverage of the local kinds was obtained); capture dates are included for my specimen. It is interesting to note that both of these earlier collections contained two species which, as far as I can see, are not present in this area anymore—or they are extremely rare. They are *Nymphalis milberti* and *Erynnis martialis*, both of which, according to Klots (1958) could inhabit this area.



Fig. 1. Sandusky River Basin, Seneca Co., Ohio.



Fig. 2. Wheat field and oak-hickory woods.

It is my hope that more such extended work will be done in other localities, for it seems to me that in the last analysis it will be the individual species in its micro-habitat that will be accounted for. I thank Dr. Howard W. Hintz of Heidelberg College for his assistance on the Heidelberg Collection; Mr. Leland L. Martin of Wellington, Ohio, for his careful help on the preparation of this list; Mrs. J. H. Hilton and Miss L. K. Fast of the Seneca County Museum for their assistance on Mr. Hepp's collection; and also my brother, with whom I have spent many a successful field trip.

ANNOTATED LIST

SATYRIDAE

Lethe portlandia (Fabricius). in the collections of Rhodes & Hepp; Capture date: 16 Aug., 64.

Lethe eurdice (Johannson). Rhodes; July, 57.

Euptychia cymela (Cramer). Rhodes & Hepp; July, 56.

Cercyonis pegala alope (Fabricius). Rhodes; Aug., 58.

Cercyonis alope nephele (Kirby). Rhodes; July, 56.

DANAIDAE

Danaus plexippus (Linnaeus). Rhodes & Hepp; Sep., 61.

NYMPHALIDAE

Euptoietia claudia (Cramer). Aug., 56.

Speyeria cybele (Fabricius). Rhodes & Hepp; Sep., 61.

Speyeria idalia (Drury). Aug., 64.

Boloria toddi (Holland). Rhodes & Hepp; Sept., 61.

Phyciodes tharos (Drury). Rhodes & Hepp; Sept., 60.

Polygonia progne (Cramer). June, 56.

Polygonia interrogationis (Fabricius). Rhodes & Hepp; June, 58.

Polygonia comma (Harris). July, 56.

Nymphalis milberti (Latreille). Sept., 56.

Nymphalis antiopa (Linnaeus). Rhodes & Hepp; June, 56.

Vanessa atlanta (Linnaeus). Rhodes; July, 57.

Vanessa cardui (Linnaeus). July, 57.

Vahessa virginienensis (Drury). Rhodes; July, 56.

Precis lavinia (Cramer). Rhodes; June, 56.

Limentis arthemis astyanax (Fabricius). Hepp; Aug., 56.

Limentis arthemis arthemis (Drury). Sighted Aug., 64.

Limentis archippus (Cramer). Rhodes; July, 56.

Asterocampa celtis (Boisduval & Leconte). Sept., 59.

Asterocampa clyton (Boisduval & Leconte). July, 58.

LIBYTHEIDAE

Libytheana bachmannii (Kirtland). July, 58.

RIODINIDAE

Lephelisca muticum (McAlpine). July, 58.

LYCAENIDAE

Strymon liparops (Boisduval & Leconte). Hepp; Aug., 60.

Strymon melinus (Huebner). Rhodes; July, 59.

Strymon falacer (Godart). July, 58.

Strymon titus (Fabricius). July, 63.

Lycaena thea (Guerin). Rhodes & Hepp; Aug., 61.

Lycaena phlaeas americana (Linnaeus). July, 60.

Everes comynates (Godart). Aug., 59.

Lycaenopsis agrioius (Linnaeus). Juune, 57.

PIERIDAE

- Colias philodice* (Latreille). Rhodes & Hepp; June, 56.
Colias eurytheme (Boisduval). Rhodes & Hepp; July, 58.
Eurema lisa (Boisduval & Leconte). July, 57.
Pieris rapae (Linnaeus). Rhodes & Hepp; June, 60.

PAPILIONIDAE

- Papilio marcellus* (Cramer). Rhodes & Hepp; Aug., 59.
Papilio troilus (Linnaeus). Rhodes & Hepp; July, 58.
Papilio philenor (Linnaeus). July, 60.
Papilio polyxenes (Fabricius). July, 58.
Papilio cressphontes (Cramer). Rhodes & Hepp; July, 60.
Papilio glaucus (Linnaeus). Rhodes & Hepp; July, 56.

HESPERIDAE

- Pyrgus communis* (Grote). July, 56.
Pholisora catullus (Fabricius). July, 62.
Erynnis icelus (Scudder & Burgess). May, 57.
Epargyreus clarus (Cramer). July, 56.
Adopaea lineola (Ochsenheimer). July, 63.
Polites peckius (Kirby). June, 59.
Polites themistocles (Latreille). Sept., 59.
Polites verna (Edwards). July, 56.
Poanes zabulon (Boisduval & Leconte). June, 57.
Poanes hobomok (Harris). July, 59.
Poanes viator (Edwards). July, 60.
Ancyloxipha numitor (Fabricius). Sept., 56.
Atrytone ruricola metacomet (Boisduval). July, 59.
Atrytone dukesi (Lindsey). July, 60.
Hylephila phyleus (Drury). Sept., 61.
Atalopedes campestris (Boisduval). August, 64.
Catia otho egeremet (Scudder). August, 64.

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ALASKA REFRESHMENTS

Butterflies of the arctic regions join in obtaining moisture from wet ground on a warm sunny day just as do tropical or temperate species of related kinds. This scene shows a roadside cut in the Tanana River Valley of Alaska, showing the primeval soil condition at the top, and the disturbed soil below. Water seepage from the peat soil above has attracted *Colias philodice vitabunda* and *Colias gigantea* males as well as an *Erebia* sp. male at the upper left center. Some blues are visible in the vicinity of the *Erebia*. Early July, 1948.

W. Hovanitz

PARALLEL ECOGENOTYPICAL COLOR VARIATIONS IN BUTTERFLIES

(cover illustration)

The illustration on the front cover of this issue is a color rendition of figure 9 in the article entitled "Parallel ecogenotypical color variation in butterflies" published in *Ecology* in 1941 (22: 259-284). The black-and-white illustrations used in that paper were reproduced from color originals. The opportunity is now available in this Journal to illustrate these in color. Since the entire paper mentioned is probably not readily available to most Lepidopterists, and the author's supply of reprints is nearly exhausted, this Journal will reproduce that entire paper if there is a sufficient demand for it.

The left column shows a typical range of variation in *Plebejus saepiolus* females from the darker at the top to the lighter at the bottom. These correspond to a northern to southern geographical distributional range in California.

Four specimens of *Apodemia mormo* are shown at the right, ranging in color from darker to lighter. These colors correspond generally to localities having a cooler-damper climate to ones having a warmer-dryer climate.

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SYSTEMATICS AND ZOOGEOGRAPHY OF THE GENUS *Phanus* (Hesperiidae)

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EXAMINATION OF THE CARNEGIE MUSEUM SERIES of *Phanus* and attempts to key them according to Evans (1952) showed that there was a new species and that another appeared to have two subspecies. Further, there were some interesting distributional patterns suggested, but, as is so often the case, more material was needed. Accordingly, I have gathered the bulk of the *Phanus* in collections for study, and all records are followed by initials representing these assemblages, as follows: AMNH (American Museum of Natural History), BM (British Museum (Natural History)), CAS (California Academy of Sciences), CDM (collection of C. Don MacNeill), CM (Carnegie Museum, including the collections formerly belonging to the Academy of Natural Sciences of Philadelphia and Lee D. Miller), and USNM (U. S. National Museum).

I would like to here express my appreciation to the following for their help and encouragement in this study: Mr. Harry K. lench and Dr. R. M. Fox, Carnegie Museum; Dr. F. H. Rindge, American Museum of Natural History; Messrs. N. D. Riley and T. G. Howarth, British Museum (Natural History); Dr. C. Don MacNeill, California Academy of Sciences; and Dr. W. D. Field, U. S. National Museum. Particular thanks go to Mr. Clench for his help in preparation of the maps. Without the help and cooperation of these people this project would have been impossible. This research was supported in part by National Science Foundation grant GB-2928.

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Genus **Phanus** Hubner, [1819]

Phanus Hübner, [1819]. Verz. bek. Schmett., (4): 114. Type species: *Papilio vitreus* Stoll, by monotypy.

Papilio vitreus Stoll, by monotypy.

Phanus is a homogeneous assemblage of skippers containing five species, three of which occur generally throughout the Neotropics, one which seems to be restricted to Mexico and northern Central America and the fifth is confined to southern Brazil, Paraguay, northern Argentina and eastern Bolivia. The sexes are similar, so the key which follows later will serve to characterize both males and females.

Evans (1952: 6) places this genus in Group B (the *Augiades* group) which he characterizes (1952: 1) as, "Third segments of palpi divergent. Wings erect in repose." The first of these statements is true for nine of the eleven included genera, *Phocides* Hübner and *Hypocryprothrix* Watson having convergent palpi, but the second statement is not universally true, if at all. I have seen members of four genera of this group in the field, including *Phanus*, and all have invariably been perched with their wings held flat.

The palpi are typical of the group as defined by Evans (1952: 5). The antennae are about half as long as the forewing costa, the club occupying the terminal third. The club is gently thickened and arcuate about the middle, tapering to a long, slender apiculus. The cell of the forewing is very long, almost three-fourths the length of the wing, and the cell of the hindwing is about half as long as the wing. The mid-and hind-tabia each bear one pair of terminal spines.

KEY TO THE SPECIES OF *PHANUS* HÜBNER

1. Distal arms of bifurcated streak in space C_1 - Cu_2 of forewing longer than undivided proximal part2.
- Distal arms of bifurcated streak in space C_1 - Cu_2 of forewing much shorter than undivided proximal part4.
2. Upper arm of bifurcated streak in space Cu_1 - Cu_2 of forewing shorter than lower arm; hindwing cell streak completely separate (often widely) from discal spot in space M_1 - M_3 (rarely slightly connected in some females); valva with long terminal spine projecting posteriad *P. obscurior*3.
- Upper arm of bifurcated streak in space Cu_1 - Cu_2 of forewing as long as lower arm; hindwing cell streak partially contiguous with, or only narrowly separated from, extradiscal spot in space M_1 - M_3 ; valva with dorsal distal lobe, no spine *P. marshallii* (Kirby)
3. Hindwing cell streak widely separated from discal spot in M_1 - M_3 ; submarginal spots in M_1 - M_2 and M_2 - M_3 are well sep-

- arated *P. o. obscurior* Kaye
 Hindwing cell streak narrowly separated from discal spot in space M_1-M_3 (slightly connected in some females); submarginal spots in M_1-M_2 and M_2-M_3 contiguous *P. obscurior prestoni*, new subspecies.
4. Hindwing cell streak widely separated from discal spot in space M_1-M_3 ; valva with strongly toothed dorsal distal lobe and prominent distal spine diverted dorsad *P. rilma* Evans
 Hindwing cell streak contiguous with discal spot in space M_1-M_3 ; valva without terminal spine 5.
5. Forewing subapical spots three times as long as submarginal spots in spaces M_1-M_2 and M_2-M_3 ; dorsal distal lobe of valva angular and strongly toothed basad *P. australis*, new species
 Forewing subapical spots not much larger than submarginal spots in spaces M_1-M_2 and M_2-M_3 ; dorsal distal lobe of valva rounded and not strongly toothed *P. vitreus* Stollo

Phanus obscurior Kaye

This species, perhaps the most distinctive of the genus, is characterized by the following: the distal arms of the bifurcated streak in forewing space Cu_1-Cu_2 are longer than the proximal united part, but the upper arm is shorter than the lower one; the hindwing cell streak is separate from the discal spot in space M_1-M_3 , except in some females of *o. prestoni*, whereas in all species but *rilma* these spots are more or less coalesced; and the genitalia of both sexes are distinctive. The male genitalia are characterized by the posteriad diversion of the dorsal distal tooth of the valva, and the uncus is greater than one-third the length of the tegumen, a characteristic shared with *marshallii*. The vaginal plate is stouter in this species than in others, as may be seen in the plate.

Two subspecies are recognized in this species; *obscurior* is the only *Phanus* that is considered to have geographic isolates.

Phanus obscurior obscurior Kaye, 1924

Figs. 1 ♂, 2 ♀, 13 valva

Phanus obscurior Kaye, 1924. Trans. Ent. Soc. London, 72: 416 (Trinidad).

The nominate subspecies occurs in Central America from at least Nicaragua south to Colombia and Venezuela and in Trinidad. It is characterized by the greater restriction of the hyaline spots, particularly those of the hindwing, as described in the discussion of the next subspecies.

Except in Trinidad nominate *obscurior* does not appear to be common. I have seen seventy specimens, forty-four males and twenty-six females, from the following localities:

NICARAGUA: "Nicaragua" (BM); Chontales (BM); San Ramon, R. Wanks (BM). COSTA RICA: "Costa Rica" (BM); San Jose (CM, USNM, BM); Cartago (CM). PANAMA: Chiriqui (BM); Veraguas (BM); Bugaba (CM); Barro Colorado Isl., ii-iii (CM, AMNH). COLOMBIA: "Interior of Colombia" (BM). VENEZUELA: "Venezuela" (BM); Puerto (Porto) Cabello (CM, BM); Las Quiguas, Esteban Valley, xi-iii (BM). TRINIDAD: "Trinidad" (BM, including type); Fondes-Amandes Road (AMNH); St. Ann's Valley (BM); Mamore, iii (BM); Maraval, i-ii, ix-xii (BM); Northern Mtns., i, xii (BM); St. George's, xi (BM); Port of Spain (BM); Broadway (BM); Caparo (BM). NO DATA: (USNM, BM).

Phanus obscurior prestoni, new subspecies

Figs. 4 ♂, 5 ♀, 12 ♂, 19 ♀ gen.

This subspecies differs from nominate *obscurior* in the more extensive hyaline markings on all wings of both sexes. The lower member of the bifurcate forewing cell streak, frequently broken in *o. obscurior*, is always entire in the present subspecies. The hindwing cell streak is elongated in *o. prestoni* toward the discal spot in M_1 - M_3 and occasionally coalesced with it in some females. The submarginal spots in M_1 - M_2 and M_3 - M_2 of the hindwing, separate in the nominate subspecies, are coalesced in the present one, although they are definitely two spots, not a single one as in *vitreus*. As in *o. obscurior* the females have more extensive hyaline markings than do the males.

Length of forewing of holotype male 22.0 mm. ; the male paratypes have forewing length between 21.5 and 23.5 mm. , averaging 22.5 mm. ; and the female paratypes range between 23.0 and 26.0 mm. , averaging 24.1 mm.

The male genitalia of *prestoni* differ in one significant respect from those of the nominate subspecies: the dorsal distal tooth does not extend posteriad beyond the posterior margin of the valva, whereas in *o. obscurior* the tooth is quite long, extending well beyond the distal margin. The female genitalia are as those of the nominate subspecies.

Described from seventeen specimens, nine males and eight females, from the upper Amazon of Brazil.

Holotype male: Nova Olinda, Rio Purus, Brazil, June, 1922 (S. M. Klages); ♂ genitalic slide no. M-375 (Lee D. Miller).

Paratypes (eight males and eight females), as follows: 1 ♂ Manacapuru, Brazil; 3 ♂ Manicore, Rio Madeira, Brazil; 1 ♂ Manicore, Rio Madeira, Brazil, xi; 1 ♂ San Gabriel, Rio Negro, Brazil; 1 ♂ Rio Tapajos, Conceicao, Brazil, ix-1931; 1 ♂ Benjamin Constant, Brazil, Borders of Peru-Colombia, 24-ii-[19]42 (F. M. Bailey); 2 ♀ Manaus, [Brazil]; 1 ♀ Solimoes, 420 mi. above Manaus, Brazil, 16-ix-1961 (F. W. Preston), ♀ genitalic slide no. M-390 (Lee D. Miller); 1 ♀ "Rio S., Brazil"; 3 ♀ Para, [Brazil] (A. Miles Moss); 1 ♀ Utinga, Belem de Para, Brazil, viii-12-[19]58.

The holotype male and four male and three female paratypes are deposited in Carnegie Museum (CM Ent. Type Series No. 508). Two male paratypes are deposited in the American Museum of Natural History. Two male and four female paratypes are deposited in the British Museum (Natural History). One female paratype is deposited in the collection of C. Don MacNeill.

It is with great pleasure that I name this subspecies in honor of Dr. F. W. Preston of Butler, Pa. who collected the illustrated female and whose gifts over the years have greatly enriched Carnegie Museum.

Fifty-six additional specimens, thirty-four males and twenty-two females, have been seen, but not included in the type series. These represent the following localities:

BRITISH GUIANA: Georgetown (CM); Warani (CM); Kartabo, Bartica dist. (AMNH); Rockstone, Essequibo (USNM); Mazaruni (BM). FRENCH GUIANA: Port Laurent (CM); St. Laurent (AMNH). SURINAM: "Surinam" or "Suriname" (BM). BRAZIL: "Brazil" (BM); Corcovado (BM); Petropolis (USNM); Rio (de) Janeiro USNM, BM; Espirito Santo (BM). COLOMBIA: E. Colombia (CM); Neiva (CM). PERU: Los Puento, ii (AMNH); Putamayo River, ix, xi (AMNH); Florida, Rio Putamayo, iv, x (BM); Pebas (BM); Iquitos, i-iv, vi-viii, xi (AMNH), BM). NO DATA: (CM, AMNH, BM).

The distribution of the subspecies of *obscurior* has interesting implications. The nominate subspecies is restricted to what might be termed "the extra-Amazonian" tropics and is replaced in the Guiana-Amazonian area by *o. prestoni*. The close affinities of these two subspecies indicates a possible recent isolation, a factor which will be discussed in greater detail later in the section on distribution.

***Phanus marshallii* (Kirby), 1880**

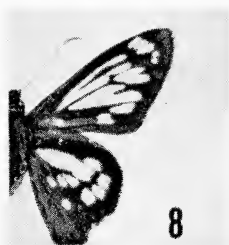
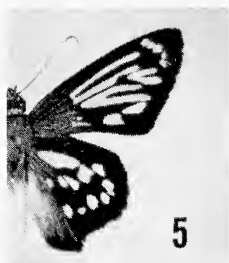
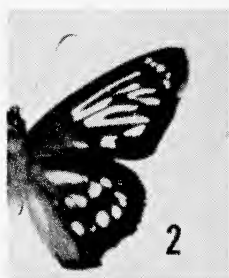
Figs. 3 ♂, 14 ♂ gen., 20 ♀ gen.

Entheus marshallii Kirby, 1880. Proc. Roy. Soc. Dublin, [1880]: 339 (Trinidad).

This species, which with *vitreus* is one of the most frequently met, is characterized as follows: the upper arm of the bifurcated streak in forewing space Cu_1 - Cu_2 is as long as the lower one, the only species in which this is true; the hindwing cell streak is separate from the discal spot in space M_1 - M_3 , though in many females these spots are connected at their upper ends; the male genitalia are characterized by the uncus being over one-third the length of the tegumen (shared with *obscurior*) and the presence of a dorsal distal lobe on the valva, toother along the posterior margin, as shown in the figure; and the vaginal plate of the female genitalia is composed of two subquadrate lobes, not so robust as in *obscurior*, but heavier than those of the other species, as shown in the figure. The available records are from Mexico throughout South America to southeastern Brazil and Bolivia.

I have examined 209 specimens, 105 males and 104 females, representing the following localities:

MEXICO: Nayarit, ix (AMNH); Atoyac, Vera Cruz (BM); Jalapa, (Vera Cruz) (BM); Piste, Yucatan, ix (CDM); Xcan, Quintana Roo, vi, vii (CM, CDM); Chiltepec, Oaxaca, x (CM). GUATEMALA: "Guatemala" (AMNH); Palin, vii (CM); Cayuga, v (CM, USNM);



Guazacapan (BM); Quirigua (BM); Senahu, Vera Paz (BM). BRITISH HONURAS: Corosal (BM). HONDURAS: Ruatan Island (BM); San Pedro Sula (BM). NICARAGUA: San Ramon, R. Wanks, vi (BM). COSTA RICA: "Costa Rica" (BM); Sixola R., iii (CM, BM); Guapiles, Prov. Limon, viii (S. P. Hubbell). PANAMA: Chiriqui (BM); Puerto Armuelles, ix (CM); Veragua(s) (BM); Corozal, ii (AMNH); Barro Colorado Island, iii (AMNH, CAS); Maddendam, C. Z. (CDM). VENEZUELA: "Venezuela" (BM); Puerto Cabello (CM, BM); Suapure, iii, iv (BM); San Esteban, v-vii (CM, BM); Las Quiguas, Esteban Valley (BM). TRINIDAD: "Trinidad" (CM, AMNH, BM); Heights of Aripo, viii (CM); Tabaquite, iii (AMNH); Port of Spain, iii (AMNH); Dabadie, iv (AMNH); Kumuto, iv (AMNH); Homomo Mt. Rd., St. Anne's, iv (AMNH); Carenage, viii (CM); St. George's (BM); Caparo (BM); St. Ann's Valley (BM); Maraval (BM); Mt. Tucuche, viii (BM); N. Mtns., xii-i (BM); Arima dist., xii-ii (BM). TOBAGO: "Tobago" (BM). BRITISH GUIANA: "British Guiana" (CM, BM); Warani (CM); Bartica, iii (AMNH, BM); Oronoque and New River heads (BM); New River (BM); Demerara R. (BM); Mazaruni (BM). SURINAM: "Surinam" (AMNH, BM); Zanderij Isl., Para dist., iv (CM, AMNH); Bronswea, iii (AMNH); Moengo, v (CM); Mana R., v (CM); St. Laurent, iii (AMNH); St. Jean, Maroni dist. (AMNH). FRENCH GUIANA: "French Guiana" (BM); Cayenne (BM). BRAZIL: "Brazil" (CM); "Brasilia" (USNM); Manicore, x (AMNH, BM); Manacapuru, iii, x (CM); Sao Paulo de Olivenca, v (CM); Santarem, viii (CM, BM); Potaro (CM); Porto Velho (USNM); Obidos, Para (or "Obydos"), vi (BM, CDM); Pernambuco (BM); Chapada (BM); Para (ex pupa) (BM); Anna R. (BM); Rio Tapajos, Conceicao (BM); Espirito Santo (BM); Uypiranga, 10 mi. from Manaus, xi, xii (BM). ECUADOR: Paramba, 3500', v (BM). PERU: Iquitos, iii (AMNH); Putamayo River, xi (AMNH); Achinamiza, i (AMNH). BOLIVIA: Rio Japacani (Yapacani), iii, ix (CM); Prov. del Sara, v (CM, BM); Coroico (CM); Buena Vista, 75 km. NW Sta. Cruz (CM, BM). NO DATA: (CM); "Amer. mer." (ex coll. Felder, BM).

***Phanus vitreus* (Stoll), 1781**

Figs. 7 ♂, 15 ♂ gen., 21 ♀ gen.

Papilio vitreus Stoll, 1781. Pap. Exot., 4: 146 (Surinam).

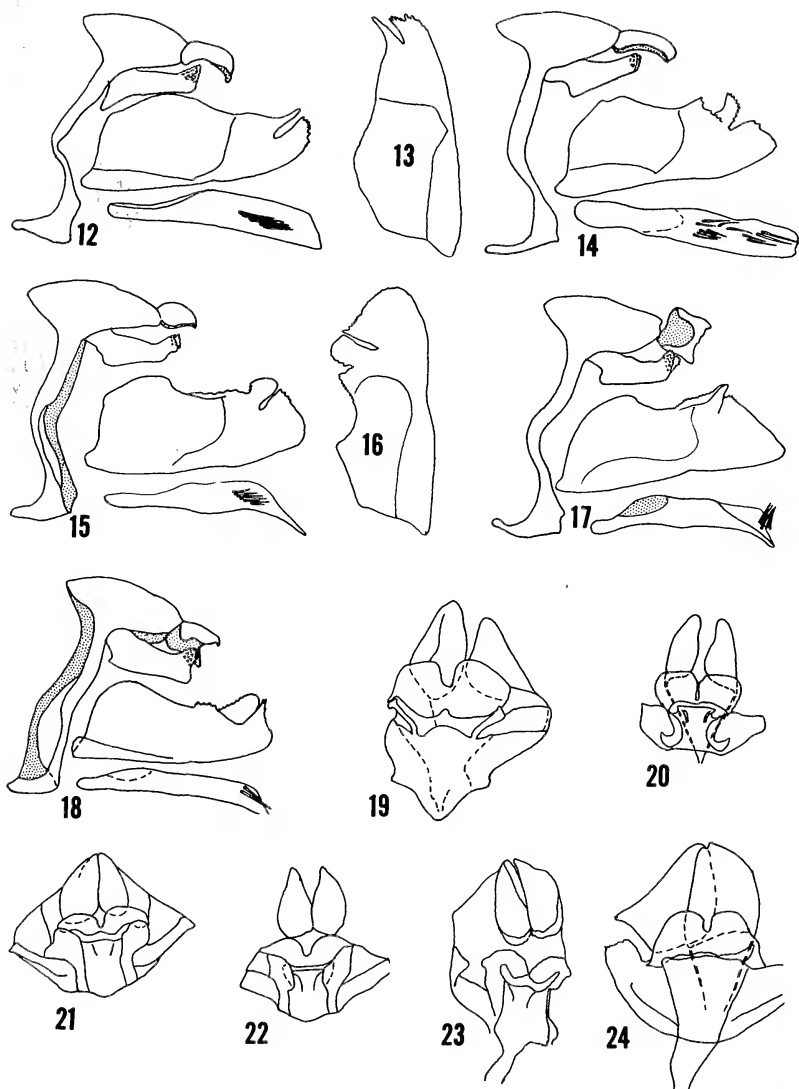
Papilio momus Fabricius, 1787. Mant. Ins., 2: 86 (Cayenne).

Phanus godmani Williams and Bell, 1931. Trans. American Ent.

Soc., 57: 286 (Costa Rica).

This species, along with *marshallii* the commonest of the genus, is at the center of a small group of closely related species to

Figures 1-11: upper surfaces of *Phanus* species. 1. *P. o. obscurior* Kaye, ♂, Bugaba, Panama. 2. *P. o. obscurior*, ♀, Barro Colorado Island, Canal Zone, Panama. 3. *P. marshallii* (Kirby), ♂, Chiriqui, Panama. 4. *P. obscurior prestoni*, new subspecies, Holotype ♂, Nova Olinda, Rio Purus, Brazil. 5. *P. obscurior prestoni*, new subspecies, Paratype ♀, Rio Solimoes, 420 mi. west of Manaus, Brazil. 6. *P. rilma* Evans, ♀, Agua del Obispo, Gro., Mexico (AMNH). 7. *P. vitreus* (Stoll), ♂, Manacapuru, Brazil. 8. *P. australis*, new species, Holotype ♂, Nova Teutonia, Sta. Catarina, Brazil. 9. *P. australis*, new subspecies, Paratype ♀, Nova Teutonia, Sta. Catarina, Brazil. 10. *Phanus* unclassified specimen No. 1, ♂, Moca, Guate. (AMNH). 11. *Phanus* unclassified specimen No. 2, ♀, Rancho Grande (Noracay), Venezuela (AMNH). Unless otherwise indicated all specimens are in the collection of Carnegie Museum.



Figures 12-24: genitalia of *Phanus* species. 12. *P. obscurior prestoni*, new subspecies, Holotype ♂ genitalia. 13. *P. o. obscurior* Kaye, ♂ valva. 14. *P. marshallii* (Kirby), ♂ genitalia. 15. *P. vitreus* (Stoll), ♂ genitalia. 16. *Phanus* unclassified specimen No. 1, ♂ valva. 17. *P. australis*, new species, Holotype ♂ genitalia. 18. *P. rilma* Evans, ♂ genitalia. 19. *P. obscurior prestoni*, new subspecies, Paratype ♀ genitalia. 20. *P. marshallii*, ♀ genitalia. 21. *P. vitreus*, ♀ genitalia. 22. *P. australis*, new species, Paratype ♀ genitalia. 23. *P. rilma*, ♀ genitalia. 24. *Phanus* unclassified specimen No. 2, ♀ genitalia.

be discussed later. Along with the next two species *vitreus* is distinguished by the bifurcated streak in forewing space Cu_1 - Cu_2 having a longer undivided proximal part than divided arms. The subapical spots on the forewing are only slightly larger than the submarginal spots in spaces M_1 - M_2 and M_2 - M_3 , thereby setting the present species apart from *australis*, and the hindwing cell streak is contiguous with the discal spot in space M_1 - M_3 , setting *vitreus* apart from *rilma*. The rounded, virtually untoothed dorsal distal lobe of the valva is also distinctive. The lobes of the vaginal plate, as shown in the figure, are more finely drawn than those of *australis* and not so contorted as *rilma*.

Phanus vitreus is recorded from Mexico through Central and South America to southeastern Brazil and Bolivia. It also occurs commonly on Trinidad.

357 specimens, 166 males and 191 females, have been examined, representing the following localities:

MEXICO: "Mexico" (CM, AMNH); Atoyac, Vera Cruz, v (CM, BM); Jalapa, (Vera Cruz) (AMNH, USNM, BM); Serrania de Moto-rango, Vera Cruz (AMNH); Presidio, Vera Cruz, iv, viii (AMNH); Teapa, Tabasco, iv (BM). "CENTRAL AMERICA": (AMNH). GUATEMALA: Polochic Valley (BM); Forests of N. Vera Paz (BM); Guzacapan (BM). HONDURAS: "Honduras" (CM, USNM, BM); "Sp. Honduras" (USNM); San Pedro Sula (BM). NICARAGUA: "Nicaragua" (BM); Chontales (BM); San Ramon, 375' v (BM). COSTA RICA: "Costa Rica" (CM, BM, including types of *godmani*); San Jose (USNM); Guapiles (USNM, BM); Carillo (CM); Port Limon, iii (USNM); Zent dist., ii (USNM); vic. Villa Neilly, Prov. Puntarenas, vii (CM); Cachi, x (BM); Estrella Riv. (BM). PANAMA: "Panama" (BM); Chiriqui (CM, AMNH, BM); David (BM); Bugaba, 1-500' (BM); Cerro Campana, 10 km. SW Campana, xii (CDM); Barro Colorado Isl., i-iii (AMNH); Gatun, C. Z., viii (AMNH); New Culebra, C. Z., x (AMNH). COLOMBIA: "Colombia" (BM); Muzo (CM); Bonda, vii (CM); Don Diego, Dept. Magdalena, v (CM); (CM); Monbornscuza, xi (AMNH); Cauca (BM); nr. Bogta (BM); "Nouvelle Granade", Cundinamarca (BM); Cananche, Cundinamarca, vi (BM); Cachabé, i (BM). VENEZUELA: "Venezuela" (CM, BM); Puerto Cabello (CM, BM); Carripito, Monagas, v (AMNH); San Esteban, vii, viii (BM); Suapure, ii, iii (BM). TRINIDAD: "Trinidad" (BM); Marval, ix (BM); Tabaquite, Narieva dist. (BM); Maracas Valley, viii (BM); Port of Spain (BM); St. George's (BM). BRITISH GUIANA: "British Guiana", ii (CM, BM); Warani (CM); Bartica, xii (AMNH, BM); Carimang (BM); Demerara (BM); Omai (BM). FRENCH GUIANA: "French Guiana" (BM, AMNH); Cayenne (B , CM); St. Laurent du Maroni (BM, AMNH); St. Jean, Maroni R. (USNM); Port Laurent (CM); Maroni R. (USNM); Mana R., v (CM). SURINAM: "Surinam" (CM, BM); Berg-en-daal, v (BM); Saramacea R. (BM); Ephrata, ii (BM). ECUADOR: "Ecuador" (CM, BM, CAS); Palmar, Manabi, iv (AMNH); Santo Domingo, ii (AMNH); Macas (AMNH); La Chima (BM); Balzabampa, Prov. Bolivar, ii (BM); Sta. Inez (BM); Aguano (BM); Paramba, iv (BM). PERU: Colonia Perene, Rio Perene, 18 mi. NE La Merced, i (CAS); Iquitos, iv-vii, ix, xi (CM, AMNH, USNM, MB); Achinamiza, i, ix (CM, AMNH); Putamayo R., xi, xii (AMNH); Upper Rio Tapeche, i

(AMNH); Rio Hullaga, xi (AMNH); La Union, R. Huacamayo, Carabaya, 2000', xi (BM); Chanchamayo (BM); La Merced, v-viii (BM); Rio Pacaya, lower Ucayali, viii-ix (BM); "Amazones" (BM); Pebas (BM); Mayobamba (BM); Florida, Rio Putamayo, iv (BM). BRAZIL: "Brazil" (CM, AMNH, BM); "Brasil" (USNM); Obidos (or "Obydos") (CM, AMNH, BM); Benevides, Para, x-xi (CM); Belem, Para, i, vii, ix (CDM); Para, viii (CM, AMNH, BM); Manicore, x xi (CM, AMNH); Manacapuru, iii (CM); Maranham (CM, BM); Barcellos, Rio Negro, vii (AMNH); Chapada (CM, BM); Panore, (CM); Arima, Rio Purus, xi (CM); "Amazons" (AMNH); Sao Paulo de Olivenca, vi-ix (BM, CDM); Teffe, Amazonas, vii-viii (BM); Maues, Amazonas (BM); Rio Ugayala (BM); Tarapote, Amazonas (BM); Cevallo-Cocho, Amazonas (BM); Bahia (BM, CDM); "Rio S." (BM); Itaparica, xii (BM); Corcovado (BM); Serra de Communaty, Pernambuco (BM); Pernambuco (BM); Ceara (BM); Porto Real (BM); Pilar, Minas Geraes, (CM); Rio de Janeiro (BM); Laguna de Sacuaresma, Rio de Janeiro, ix (BM); Espirito Santo (BM); St. Catherine's (CM); Joinville, Sta. Caraina, iv (AMNH). BOLIVIA: Buenavista, 75 km. NW Sta. Cruz (CM, BM, AMNH); Rio Surutu, iv (CM); Cuarto Ojas, Dept. Sta. Cruz, xi (CM); Prov. del Sara, ii-iv, vi (CM, BM); Rio Songo (CM); oroico (CM); Upper Mamore R. (CM); Rio Japacani, viii (CM); Reyes, vii (BM).

***Phanus rilma* Evans, 1952**

Figs. 6 ♀, 18 ♂ gen., 23 ♀ gen.

Phanus rilma Evans, 1952. Cat. American Hesperidae, 2:21 (Guerrero, Mexico).

This is the rarest *Phanus*, apparently restricted to Mexico and Guatemala, although one female from Venezuela may represent an unnamed subspecies of it. *P. rilma* may be distinguished from other members of the *vitreus* group by having the hindwing cell streak widely separated from the discal spot in space M_1-M_3 . The configuration of the bifurcate streak in forewing space Cu_1-Cu_2 definitely separates this species from both *marshallii* and *obscurior*. The male genitalia are of the *vitreus* type with the very short uncus, but the valvae are distinctive: there is a dorsal distal spine, diverted dorsad, and the dorsal lobe is toothed on its proximal margin. The contorted vaginal plate of the female genitalia is distinctive, as shown in the figure.

I have seen only six specimens, three males and three females, representing the following localities:

MEXICO: Guerrero (BM, including type); Agua de Obispo, Gro., vii (AMNH). GUATEMALA: "Guatemala" (AMNH).

***Phanus australis*, new species**

Figs. 8 ♂, 9 ♀, 17 ♂ gen., 22 ♀ gen.

Sexes similar. This species is nearest *vitreus*, differing superficially in the following respects: the three forewing subapical spots are much larger, always three times the size of the submarginal spots in M_1-M_2 and M_2-M_3 , whereas in *vitreus* the subapicals are rarely twice the size of the median submarginal spots; the proximal margin of the upper opaque white spot in forewing

space Cu_2 -A overlaps the distal half of the lower spot in the present species, and in *vitreus* the proximal margin of the upper spot is generally distad of the entire lower spot; the upper arm of the bifurcated hyaline streak in forewing space Cu_1 - Cu_2 , never half as long as the lower arm in *vitreus*, is greater than half as long as the lower arm in *australis*, occasionally the arms are almost equal; and the genitalia are different, as outlined below.

Length of forewing of male holotype 21.0 mm., the male paratypes range between 19.0 and 21.0 mm., averaging 20.4 mm., and the female paratypes range from 19.5 to 22.0 mm., averaging 21.2 mm.

The male genitalia are of the *vitreus* type, differing from that species chiefly in the configuration of the valva. The dorsal lobate process at the distal end of the valva of *vitreus* is represented in *australis* by a long, tooth-like lobe. Just proximad of this lobe is a dorsal toothed ridge, much more pronounced than that of *vitreus*, with teeth basad of the lobe. The distal margin of the valva is more or less angular, in this respect approaching *marshallii*, whereas the valva of *vitreus* is more or less rounded distally.

The female genitalia are nearest those of *vitreus*, but the vaginal plate is heavier than that of the latter species, as shown in the figure.

Described from 116 specimens, sixty-one males and fifty-five females, from southeastern Brazil.

Holotype male: Nova Teutonia, 27° 11' S., 52° 23' W., [Sta. Catarina], Brazil, 3.vi.1940 (Fritz Plaumann), 300-500 m.; ♂ genitalic slide no. M-373 (Lee D. Miller).

Paratypes (sixty males and fifty-five females), as follows: Same locality and collector as holotype: 2 ♂ 1 ♀ vi-1939, 1 ♂ 1 ♀ xii-1939, 1 ♀ v-1940, 2 ♂ 1 ♀ vi-1940, 7 ♂ 4 ♀ xii-1957, 1 ♂ 2 ♀ i-1958, 2 ♂ 3 ♀ v-1961, 3 ♂ 7 ♀ vi-1961, 1 ♂ vii-1961, 1 ♂ xii-1961, 1 ♂ vii-1958, 1 ♂ 2 ♀ xii-1958, 3 ♂ 2 ♀ vi-1959, 1 ♀ xii-1959, 1 ♀ iii-1960, 7 ♂ 6 ♀ xii-1960, 17 ♂ 9 ♀ i-1961, 2 ♂ ii-1961, 2 ♀ iii-1961, 2 ♂ 3 ♀ v-1961, 3 ♂ 7 ♀ vi-1961, 1 ♀ vii-1961, 1 ♀ xii-1961, 2 ♀ iii-1961, 2 ♂ 3 ♀ v-1961, 3 ♂ 7 ♀ vi-1961, 1 ♀ vii-1961, 1 ♀ xii-1961; 2 ♂ 4 ♀ Massaranduba-Blumenau, Brazil; 3 ♂ 2 ♀ New Bremen, Sta. Catarina, Brazil; 1 ♀ Annaburg, Brazil; 2 ♂ Castro, Parana, Brazil; 1 ♂ Tibagy, Parana, [Brazil], 2400', 23-iii-1910 (E. D. Jones); 1 ♂ Guarapurya, Parana, Brazil, Feb., 1960 (J. Kesselring); 1 ♀ Espirito Santo, [Brazil] (ex coll. Fruhstorfer); 1 ♀ S. Paulo [Brazil].

The holotype male and twelve male and twelve female paratypes are deposited in Carnegie Museum (C.M. Ent. Type Series No. 509). Nine male and eight female paratypes are deposited

in the American Museum of Natural History. Two male and two female paratypes are deposited in the British Museum (Natural History). One male paratype is deposited in the U. S. National Museum. Thirty-six male and thirty-three female paratypes are deposited in the collection of C. Don MacNeill.

In addition to the type series nineteen specimens, ten males and nine females, were examined from the following localities:

BRAZIL: Joao Pessoa, Paraiba, vi, x (CDM). PARAGUAY: Sapucay, xii (CM, BM); Carguazu, iv (CDM). ARGENTINA: Dos de Mayo, Misiones, 300 m., iii (CDM). BOLIVIA: Buenavista, 75 km. NW of Sta. Cruz (CM, BM); Rio Songo (CM); Prov. del Sara, v-vi (CM).

This species has consistently passed in collections as *vitreus*, from which it is quite distinct. The two species are sympatric in many parts of the range of *australis* (Prov. Santa Catarina and Espirito Santo, Brazil and Buenavista, Rio Songo and Prov. del Sara, Bolivia), with *australis* being apparently the more abundant species in these areas. Specimens referred to *vitreus* from the range of *australis* should be checked carefully; many will prove to be the latter.

Unclassified specimen No. 1

Figs. 10 ♂, 16 valva

This male (Moca, Guate., Aug. 31, '47; ♂ genitalia slide no. M-512 [Lee D. Miller]) is probably an aberrant *vitreus*, but, as shown in the figure, the hindwing cell streak is partially separated from the discal spot in space M_1 - M_3 , the only "*vitreus*" to show this feature. This specimen is definitely not referable to *rilma*, the genitalia being much closer to those of typical *vitreus*. The specimen is in the collection of the American Museum of Natural History.

Unclassified specimen No. 2

Fig. 11 ♀, 24 ♀ gen.

This female (Rancho Grande (Noracay), Venezuela, vii-28-'46, Flemming; ♀ genitalic slide no. M-516 [Lee D. Miller]) is closest to *rilma*, as shown in the figure, but the hyaline markings are more extensive. The female genitalia, however, are quite different. It is difficult to ascertain whether this variation is within or without the normal range for *rilma*, since I have only had the opportunity to dissect one female of that species. While this specimen undoubtedly represents a nameable entity, whether it is a separate species or a subspecies of *rilma*, I hesitate to name it on the basis of a single female. This specimen, too, is in the collection of the American Museum of Natural History.

RELATIONSHIPS WITHIN THE GENUS *PHANUS*

There appear to be three fundamental groupings within the genus, two of which are monotypic. Of these the furthest removed from the others is *obscurior*. The male and female genitalia, as well as the pattern, of this species are less like those of the other species than between any pair of the other members of the genus. The long uncus of *obscurior* is more like that of *marshallii*, a species which seems to occupy a central position between *obscurior* and the *vitreus* group, than any other species. This leads to a possible explanation that the primitive *Phanus* may have been like *marshallii*, and it gave rise to both *obscurior* and the *vitreus* complex. If this is true *obscurior* probably arose first since it is less like *marshallii* than are any of the *vitreus* group. Within the *vitreus* group the most aberrant species is *rilma* which significantly approaches *marshallii* in several important respects, such as the separation of the hindwing cell streak and the discal spot in space M_1-M_3 and the configuration of the dorsal valva lobe. Therefore, *rilma* is considered more primitive than the other two species in the *vitreus* group, *vitreus* and *australis*, which are very close and probably arose rather late chronologically.

THE DISTRIBUTION OF *PHANUS*

The distribution of *marshallii* has not been mapped, but it is one of the most generally distributed species of the genus, found from Mexico to central Brazil and eastern Bolivia and in Trinidad. It is apparently absent from southeastern Brazil, Paraguay and northern Argentina, the metropolis of *australis*.

The locality records for the subspecies of *obscurior* are shown in Fig. 25, along with projected actual ranges. Nominate *obscurior* is found throughout Central America and at least coastal Venezuela and Trinidad, whereas *prestoni* has been recorded from the Guianas and the Amazon valley. The available records show only one country from which both subspecies have been taken, Colombia. The two records of *prestoni* are from eastern Colombia, and I feel that the ambiguous "Interior of Columbia" record of *o. obscurior* probably refers to a specimen taken west of the Cordillera. It seems likely, too, that nominate *obscurior* will be found in northwestern Ecuador. Just when the isolation of *o. obscurior* and *o. prestoni* took place is difficult to ascertain, but it seems well established that the latter arose in an area bounded on the north by the Guiana highlands and the Venezuelan savannah, and on the west by the Andean front, whereas the nominate subspecies may well have arisen in Central America.

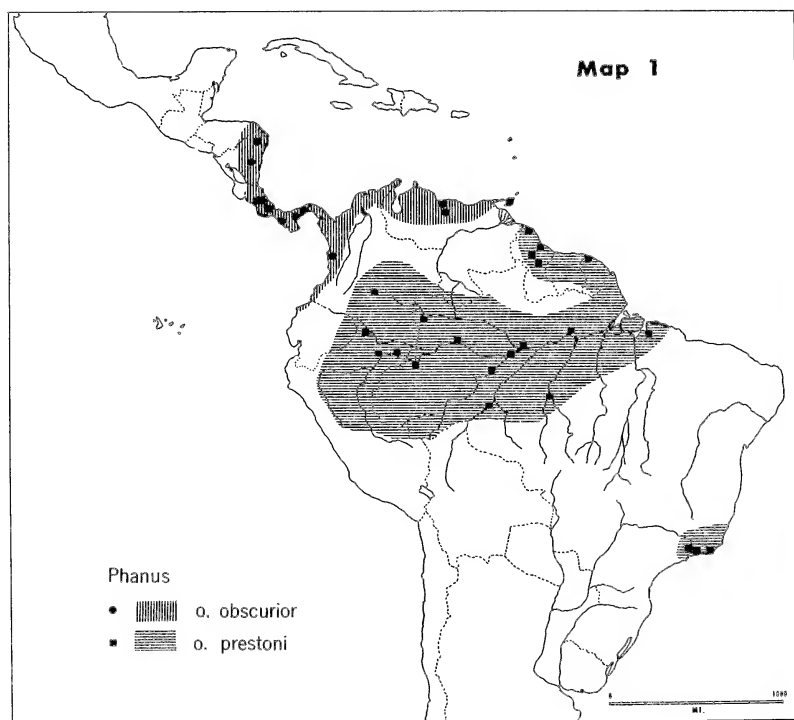


Fig. 25: The distribution of the subspecies of *Phanus obscurior* Kaye.

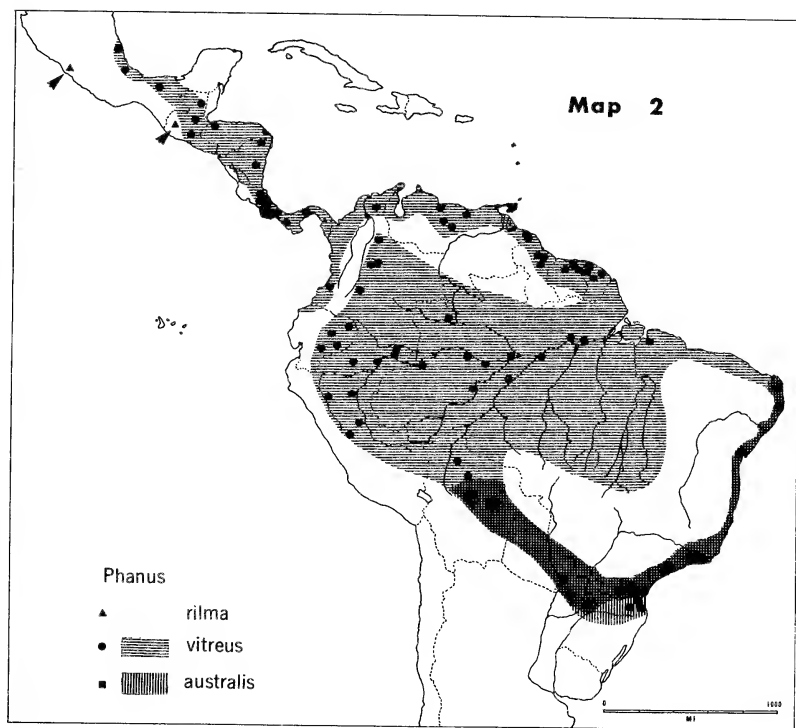


Fig. 26: The distribution of the *vitreus* complex of the genus *Phanus* (*vitreus* [Stoll], *rilma* Evans and *australis*, new species).

The distribution of the *vitreus* complex is shown on Fig. 26. Here one sees a widely distributed species which quite possibly gave rise to two other species at the opposite ends of its range. It is significant that the most aberrant member of the *vitreus* group, *rilma*, is found in Mexico and Guatemala, an area more or less cut off from the rest of the Neotropics during the Tertiary (Darlington, 1957: 285). It seems likely that a relatively undifferentiated *vitreus*-like stock was isolated there (as were several other butterflies, such as *Baronia brevicornis* Godman and Salvin) fairly early, and the resultant evolution produced this aberrant *vitreus* relative. More recently and at the opposite end of the range *vitreus* split into two isolated groups, one in the highlands of southeastern Brazil and the other possibly near the Guiana highlands, perhaps as a result of flooding of the Amazon basin. The southern group evolved into *australis*, which was sufficiently distinct to resist subsequent reinvasion by the *vitreus* stock into southern South America. The latter species has never been as successful in this area as has *australis*, but *vitreus* has widely established itself—from Mexico to southeastern Brazil and Bolivia and in Trinidad.

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COMMENTS ON THE GENUS *CERCYONIS* SCUDDER

WITH FIGURES OF TYPES (SATYRIDAE)*

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IT IS PERIODICALLY NECESSARY to review each genus that is composed of dynamic species and especially to re-assess the earlier opinions of taxonomists in the light of newer knowledge. This is especially true for names that have long been relegated to synonymy. During a study of the names proposed by William Henry Edwards for the North American Satyridae described by him. I have become quite familiar with the extant types for all of the names proposed in the genus *Cercyonis*, a genus that is confusing to most students of North American butterflies.

In the past several serious studies of the genus have been made. W. H. Edwards proposed a large number of the names now in use and carried out extensive studies of the life histories of these insects. He wrote two syntheses of the genus, the last in 1880. W. J. Holland (1898, 1931) reviewed the entire North American fauna in his "Butterfly Book" in which he adopted an approach that is closer to Linnaean than modern. Dr. J. McDonnough carefully reviewed the genus in preparation of two check-lists but did not publish all of his findings. Weymer's analysis of the genus in Seitz' (1911) largely followed Holland. Dr. John A. Comstock inquired critically into the Californian species for his "Butterflies of California" (1927). Dos Passos (1964) in his check-list largely followed McDonnough. None of these later authors published a critical study of the genus as a whole. Such a study is needed, and is in progress by several rhopalocerists.

Three generic names have found common acceptance for the genus at different times. Throughout the nineteenth century, *Satyrus* Latreille was popular. According to Hemming (1931) the type species of this genus is *Papilio galathea* Linnaeus, 1758. In this he followed Scudder, 1875. In Opinion 142 of the International Commission on Zoological Nomenclature, published

*This study developed from my study of W. H. Edwards's types of Satyridae which was supported by N.S.F. Grant GB-194.

March 25, 1943, the generic name *Satyrus* Latreille, 1810, was placed on the Official List of Generic Names in Zoology (No. 569) with *Papilio actaea* Esper [1780] as the type species.

In [1810] Huebner used the generic name *Minois* for the Linnean species *Papilio phaedra* (1764), which Scopoli had named *Papilio dryas* in 1763, and for six other species. Butler (1868) selected *phaedra* as the type from this array.

Scudder validated Speyer's manuscript name *Cercyonis* (1875a) with *Papilio alope* Fabricius, 1793, as the type.

Superficially, the three type-species, while specifically distinctive have been considered very much alike. The two European species, types of *Satyrus* and *Minois*, have only the subcostal vein of the fore wing inflated. The type of *Cercyonis* has this vein grossly inflated and the base of the cubital vein quite noticeably so. Also, the spines on the mid tarsii are arranged differently on *Cercyonis*.

Lee Miller (*in litt.*) has given me the benefit of his doctoral thesis (University of Pittsburgh, Pennsylvania, 1965), a study of the genera of the Satyridae. On the basis of very careful anatomical studies of the type-species of the generic names that have been proposed, Miller has come to the conclusion that not only is *Cercyonis* not synonymous with either *Satyrus* or *Minois*, but it is a member of a different tribe. *Satyrus* and *Minois* are members of the tribe Satyrini in the subfamily Satyrinae. The nearctic members of this tribe are *Neominois* and *Oeneis*. The genus *Cercyonis* is the only nearctic member of the tribe Maniolini, another tribe within the subfamily Satyrinae. It is only through such careful studies as Miller's, on a world-wide basis, that order comes from the chaos of many studies of restricted faunae.

In this paper I have brought together the information that I have found about the names proposed by Fabricius, Boisduval, Kirby and Behr that now are included in *Cercyonis*. This is what was known of the genus before Edward's work, which was previously reviewed by me (1964). Here I treat only the nomenclatorial problems. The taxonomic problems will be treated in studies now under way by several specialists studying the genus.

I. Johann Christian Fabricius (1745-1808)

The honor of naming the first member of this genus falls to Linnaeus's student Fabricius. It is apparent that Peter Kalm who collected in "Pennsylvania and Canada" in 1747 for his old professor, Linnaeus, did not capture any specimens of species now included in *Cercyonis*. Fabricius named two species from North America, *pegala* and *alope*.

Mrs. Ella Zimsen, the Danish authority on Fabricius, has written to me (25.ii.65) about these species. "Fabricius met Mr. Hunter, the reknown anatomist, during his stay in London in 1767, from whose collection he described a great number of insects, including *pegala* . . . Hunter's collection is now kept at the University of Glasgow, where the species is represented by two specimens." Thus the types of *pegala*, two hundred years old, are preserved. I wrote to the University of Glasgow and through the goodness of Dr. Roy A. Crowson I am able to reproduce here photographs of the types.

Mrs. Zimsen continued, "*Papilio alope* F. was described . . . and the locality and collector were given as ex India Dom. Francillon. The type of *alope* probably has been lost, no specimen exists in Fabricius's collection, and I have not been able to find any information about Francillon. Fabricius was domiciled for many years in Paris and may here have described the species from Francillon's collection, which most probably exists no more. The locality must be a misprint made by Fabricius, maybe the locality should have been "ex Indiis Francillon" = The West-Indian Islands." What I have found out about Francillon's collection I have detailed in my discussion of *alope*.

The results of Mrs. Zimsen's careful studies have been published and a full reference will be found in the bibliography of this paper.

"*Papilio Pegala*"

1775. *Systema Entomologiae, etc.* no. 223, p. 494.

The key phrase in the original description is "*anticis fascia rufa ocelloque unico*". True *pegala* thus is recognized by the rust-tinted yellow field on the upper side of the fore wing in which there is a single ocellus (anterior). This is the form that is found in the coastal woodlands of southern Georgia and from there northward. It is distinctly maritime and not found inland. Inland its place is taken by *alope* as far south as Georgia. There is a tendency for *pegala* to be somewhat larger than *alope*, especially the females. Also, on the underside of the hind wings the ocelli that compose the anterior triad all are clearly oval, or at least the second and third are. The third ocellus in this group is almost circular on *alope*.

Fabricius and his brother visited England for the first time in 1767. They spent the summer riding and collecting in the Scottish Highlands and in the fall of the year rode south to London.

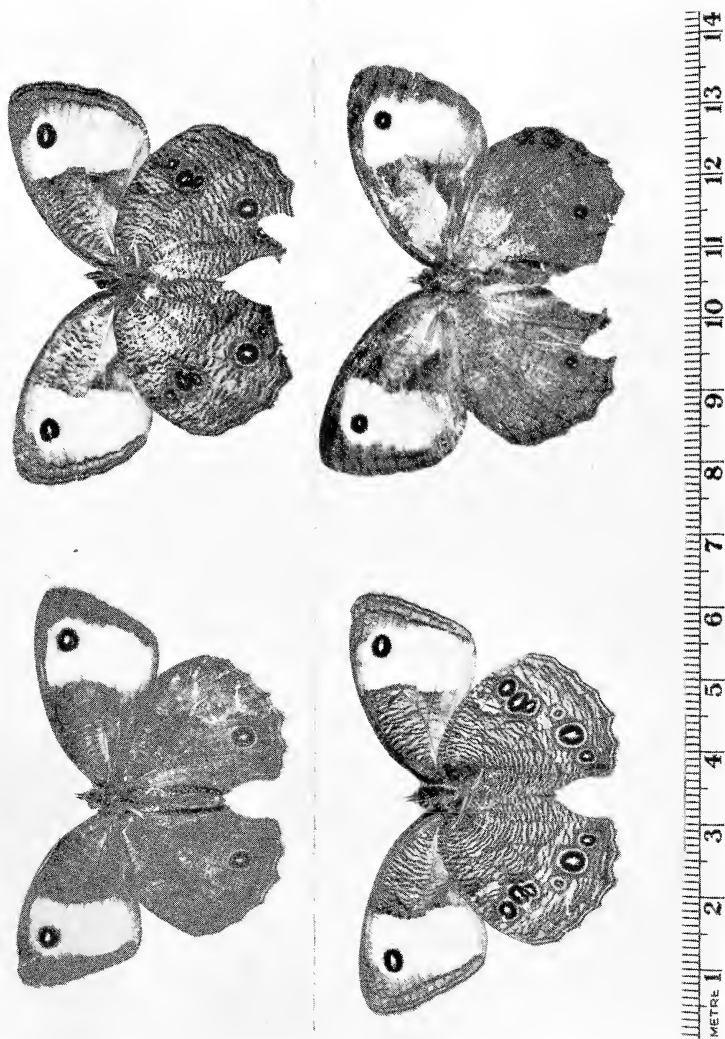


Fig. 1. *Papilio pegala* Fabricius: lectotype (left) and paratype (right) in the zoological museum, The University, Glasgow, Scotland.

"There Fabricius met Solander, who was attached to the British Museum. Fabricius' days were now spent on working on entomology, and in the evenings he would frequent the scientific club where he met Hunter, Drury, Eaton, Fothergill, and several others. All of them opened their homes to him, and he was free to go through their collections and describe new species." (Zim-sen, 1964, p. 8) Fabricius returned to Copenhagen in the fall of 1769 but returned to London each summer for several years thereafter to continue his work on the collections of his friends.

Dr. John Hunter (1728-1793) is well-known for his contributions to anatomy. After serving an apprenticeship to his brother William and other doctors in London, he was accepted as an army surgeon, and, attached to the British Navy, he sailed to the Spanish Main during the Seven Years War. While in this service he collected insects on the island of Jamaica and in Carolina. The ships of the British Navy used Charleston, South Carolina, as a provendering port during the early 1750's at the time Hunter was serving with the fleet. The region around Savannah, Georgia, tacitly has been considered the probably type locality for *pegala*. This cannot be defended on the basis of history. At the time in question that area of the coast was being claimed, and raided, by the Spaniards. The port of Savannah was not a safe one for the British fleet.

Thus on the basis of history and Hunter's presence with the British fleet, I am here designating the vicinity of Charleston, South Carolina, as the most appropriate type locality for *pegala*.

The two specimens from Hunter's Collection in the museum at The University, Glasgow, are typical of the sort of *pegala* found in the more northern parts of the range of the taxon. Thus the insects themselves support the restriction of the type locality to Charleston. One of the specimens is in perfect condition, an amazing fact considering that it had been collected over two hundred years ago. The other is somewhat rubbed, lacks one antenna and the anal angles of the hind wings are somewhat torn. Dr. Crowson suggested that the more perfect specimen be selected as the lectotype. In this I concur. Not only is it in better condition but of the two it fits perfectly Fabricius's original description. The remaining specimen is the paratype of the name. Both of these historic specimens are figured here.

“*Papilio Alope*”

1793. *Entomologica Systematica, etc.* 3:229, no. 715

The key phrases in this description are “*fascia flava; ocellis duobus*”. True *alope* bears a yellow field on the fore wing in which there are two ocelli. This is the characteristic form from the North Atlantic states. The only Indian butterflies that approach the description of *alope* are *Eumenis*, and these do not show six ocelli on the underside of the hind wing. Usually there is no more than one minute ocellus present on Indian *Eumenis*. There is no question but Fabricius had before him the North American butterfly known as *alope*.

To fix upon a probable type locality for *alope*, it has been necessary to search out what I could about Francillon. While reading through Kirby's part of “Fauna boreali-America” in search of information about the source of *nephele*, I discovered that Francillon's collection has been dispersed through sales. Thus the possibility that the type of *alope* exists and can be recognized is very slight. All of my inquiries about it have been fruitless.

John Francillon had been a silversmith in London, England, with a place of business on the Strand. He possessed a very fine collection of insects and, apparently, had been one of the several English entomologists who had employed John Abbot to collect for them in America. Francillon acted as Abbot's agent in England and disposed of both the insects Abbot sent and the water-colour plates of birds, insects and flowers that he produced in great numbers. It seems most probable that Abbot was the collector of the type of *alope*.

If this reasonable assumption is accepted, then the movements of Abbot in America before 1793 are important to us. John Abbot arrived on the James River in Virginia on September 9th, 1773. He stayed in Virginia through 1775 and then moved to Georgia. He served with the Revolutionary Army during the American Revolution and for his services was granted something over 500 acres of land in Georgia. While in Virginia Abbot collected insects and made water-colored drawings which he sent back to England for disposal. There were two such shipments and both were lost at sea. Thus, unless Abbot retained Virginian material when he moved to Georgia, none of his collections made in the first two years of his stay in America survived.

Abbot first settled in Burke County, Georgia, and spent most of his sixty years in America in that county, Screven County and

Bulloch County, although he lived for short periods around Savannah. I believe that the most likely source of the type of *alope* is the Burke-Screven-Bulloch counties region of Georgia and here restrict it to that region. When a neotype is selected for the name *alope* it should come from that area and then the locality from which the neotype came will further restrict the type locality.

II. William Kirby (1759-1850)

William Kirby was an English clergyman whose avocation was the study of insects. He contributed the section on insects to John Richardson's account of the natural history materials brought back to England by Captain Sir John Franklin's expeditions to boreal North America. There were three of these expeditions, the last of which resulted in the death of Franklin and his entire party. Kirby's account reported all known species from what now is Canada. The majority of these were from his own collection, not from collections made by the Franklin expeditions.

To settle upon a probable type locality for *nephele* it has been necessary to discover something about "Dr. Bigsby". Through the courtesy of the librarians of the University of Toronto and of the Hudson's Bay Company, I have learned a great deal about the man. Dr. John Jeremiah Bigsby (1792-1881) was trained as a doctor of medicine. Soon after graduating from the University of Edinburgh he joined the army and in 1818 was sent to Canada. There he developed his great interest in geology. The gold Bigsby Medal of the Geological Society, awarded biennially to outstanding students of American geology who are under 45 years of age, was made possible by him. In 1819 he was commissioned to study the geology of Upper Canada and in 1822 he became the medical officer and secretary of the British party engaged upon a survey of the international boundary between the United States and Canada. He returned to England in 1827 and settled in Newark, Nottinghamshire, England, where he practiced medicine until 1846, when he moved to London.

During his exploration of western Ontario, Bigsby collected insects of all sorts and sent them to the Rev. William Kirby. These Kirby included in his study of the insects of northern America, part IV of "Fauna boreali-America". Bigsby published an account of his explorations in Canada in two volumes in 1850. This he titled "The Shoe and Canoe." From this account it is possible to restrict somewhat the type locality of *nephele* from "Canada". With a firm confidence it can be said that the type

of *nephele* was collected in western Ontario in the vicinity of the Great Lakes. Most of the insects noted by Kirby as received from Dr. Bigsby came from the shores of Lake Huron and the vicinity of Lake St. Claire.

Dr. Bigsby placed at the end of volume two of "The Shoe and Canoe" an appendix (C) listing the insects that he had collected on his journeys in Upper Canada and had sent to Kirby. As a preface to this list he stated that the majority of the specimens were taken along the northern shores of Lake Huron. In this list those specimens collected at Lake St. Claire are specifically marked as such. No statement is made for *nephele* other than "Upper Canada". Elsewhere I have published (1965) the details of my search for the precise localities from which Bigsby sent material to Kirby. Suffice to say here that the type locality for *nephele* is the Canadian islands at the extreme eastern end of the waterway that connects Lake Superior with Lake Huron.

The discovery of the type locality for *nephele* poses a critical taxonomic problem. All of our biological knowledge of *nephele* rests upon W. H. Edwards's assumption that the dark form of *alope* found in the Catskill Mountains and elsewhere in the North Atlantic States is *nephele*. Edwards separated *olympus* from *nephele* on the basis of the difference he observed in the markings of the late instar larvae. The type locality for *nephele* lies closer to the source of *olympus*, the vicinity of Chicago, Illinois, than it does to the source of Edwards's "*nephele*" larvae, the Catskills. Until two things are done we will not know whether or not *nephele* Kirby and *olympus* Edwards are synonymous. These are: 1.) proof that the larvae of *olympus* are constantly different from the larvae of eastern *alope* in the late stages; and, 2.) proof that the larvae of *nephele* Kirby are like those of *alope* or like those of *olympus* in their late stages.

A search for the type of *nephele* Kirby has been unsuccessful. According to the records of the British Museum (N.H.) Kirby's insect collection was received by them. Capt. N. D. Riley, Keeper-emeritus of the Lepidoptera, made a search for me to locate the type of *nephele*. The result of the search revealed that there are no Kirby butterflies at the museum. Either Kirby disposed of them elsewhere or they no longer can be recognized. The botanist Hooker, at the University, Glasgow, was a good friend of Kirby and through him Kirby studied the butterflies and other insects at that institution. Dr. Crowson informed me that there is no Kirby material there. Other inquiries have been equally negative. Thus I am forced to conclude that the type of *nephele* no longer exists or no longer is recognizable. This means that

one of the current specialists reviewing the genus should select a specimen from the region that is the type locality as neotype for the name.

III. Jean Baptiste Alphonse Dechaullour de Boisduval (1799-1879)

The first western members of the genus *Cercyonis* were described by Boisduval. These had been collected by Pierre Joseph Michel Lorquin (1797-1873) who had joined the gold-rush of 1849 to California and stayed to collect insects. Boisduval had the degree Doctor of Medicine and his entomological interests were avocational. The record of Boisduval's studies of Californian butterflies collected by Lorquin are found in two papers, the first published in 1852 and the second in 1868-1869. In the first of these he described *Satyrus ariane* and *Satyrus sthenele*, in the second *Satyrus oetus*. All three now are included in *Cercyonis*.

"*Satyrus ariane*"

1852 — *Annales de la Société Entomologique de France*, ser. 2, 10:307.

Fordyce Grinnell (1904) presented a brief account of Lorquin learned from his son. From this it appears that Lorquin arrived in California in 1850, and immediately traveled to the placer mines in Tuolumne County where he may have combined gold-washing, the practice of law and collecting insects. In 1852 Lorquin sent for his family and after their arrival set out upon a tour of northern California. Boisduval (1868 p. 6) notes that Lorquin was not successful at the mines and retreated to San Francisco before sending for his family. Thus we are restrained in selecting a type locality for *ariane* by what is known of Lorquin's movements in California after his arrival and previous to the publication of the name *ariane* in 1852. I here restrict the type locality from "Californie" to Tuolumne County, California, and leave further pin-pointing to one of the specialists studying the genus.

The types of *ariane* are preserved in the United States National Museum in Washington, D. C. They arrived there with the William Barnes Collection, having previously been owned by Oberthus who had received them from Boisduval. There are four specimens of *ariane* from the Boisduval collection, two males and two females. This is the usual suite preserved by Boisduval when material was available. From the description it is obvious that the males and not the females were under consideration by Bois-

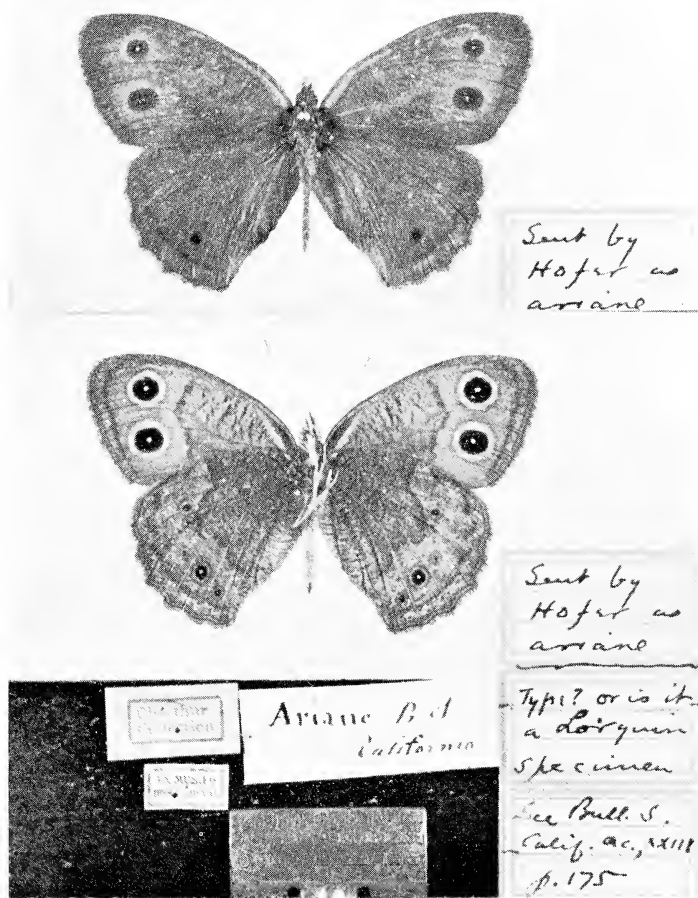


Fig. 2. *Satyrus ariane* Boisduval: lectotype in United States National Museum.

duval at the time he proposed the name *ariane*. In fact, the females may be *boopis* Behr, as suggested by Dr. John A. Comstock (1924). One of the males is accompanied by Boisduval's handlettered label "Ariane Bd / California". This specimen is perfectly described in the original description and probably was the model for Oberthur's figure 2180 on plate CCXL in volume IX of his "Etudes de Lepidopterologie Comparee." His figure 2181, on the same plate, is a female from the two just noted. Here I reproduce a photograph made by Mr. Cyril F. dos Passos of the male I have selected to be the lectotype. It is the male specimen noted above as probably the model for Oberthur's figure 2180.

"Satyrus sthenele"

1852 — *Annales de la Societe Entomologique de France*, ser. 2, 10:308.

Boisduval erroneously stated, "il vole dans le lieux eleves en juillet". This species was known only from San Francisco where it is now extinct. Lorquin probably collected the Boisduval material when he first landed in 1850, or upon a subsequent visit to the city during 1851. Thus the type locality for *sthenele* is San Francisco, California, but this only is of historic interest.

There are two Boisduval specimens in the Barnes Collection at the United States National Museum. The male of this pair is accompanied by a label hand-lettered by Boisduval, "Sthenele B.d. / Californ." This specimen I designate the lectotype of the name. It is the model for Oberthur's (l.c.) male figure 2182 of *sthenele*.

"Satyrus oetus"

1869 — *Annales de la Société Entomologique de Belgique*, 12:63.

Boisduval's description of the type locality is "Il se trouve dans le lieux rocailleux des montagnes en juillet." This is less than accurate since *oetus* is not a butterfly of the rock slide but of the dry grasslands and scrub. Such areas often are pebble paved and this is what Lorquin may have meant and was confused by Boisduval.

Early American students of butterflies were confused about *oetus* and it was not until the closing years of the 1870's that the species was properly recognized. This happened only because Boisduval loaned W. H. Edwards the type of *oetus* for comparison with material in collections in this country. The usual confusion was between *oetus* Boisduval and *silvestris* Edwards. In fact, Boisduval himself was inclined to believe that he had re-described *silvestris* when he named *oetus*. As a result, Boisduval's female specimen is accompanied by his label which read "Silvestris Edw. / oetus B. Calif."



Fig. 3. *Satyrus sthenele* Boisduval: lectotype in United States National Museum.

There are two females of *oetus* in the Barnes Collection at the United States National Museum that had been in Boisduval's collection. One of these Oberthur labeled a male (figure 2203), the other correctly (figure 2204).

Neither the notes made by W. H. Edwards nor those of Henry Edwards from the specimen loaned by Boisduval to W. H. Edwards states the sex of the specimen. Neither of the two females from the Oberthur Collection wholly satisfies Boisduval's description of that sex. Both have only one ocellus on the upper side of the fore wing. It is obvious that Boisduval had other specimens of *oetus* than we now recognize as his. However in dealing with collections over a hundred years old it sometimes is necessary to make shift with what is available. In this case it appears that one of the females will have to stand as the lectotype. Thus I name the specimen called "type" by Oberthur and used as the model for his figure 2204 the lectotype of *Satyrus oetus*



Fig. 4. *Satyrus oetus* Boisduval: lectotype in United States National Museum.

Boisduval. This specimen was chosen because the other had been erroneously named a male (fig. 2203) by Oberthur and because the shape of the apical ocellus on the underside of the fore wings of that specimen is malformed.

We have no way to determine where the lectotype came from in California. I leave the nomination of a type locality to the taxonomists dealing with the problem. Boisduval (1868 pp. 6-7) gives a little information to guide that selection. I quote here pertinent parts of Boisduval's delightfully Gallic account.

"Devenu plus libre de sin temps at eyant près de lui sa famille qui était venu le rejoindre, il sentit l'amour des sciences naturelles et surtout de l'entomologie se réveiller en lue. Pour se livrer à ses gout, il ne craignit pas s'imposer de rudes privations et de grandes fatigues: il explora d'abord tous les environs de San Francisco, puis les bords du Sacramento et le la Plume, fit des voyages dans le chaîne de la Sierra-Nevada et s'aventura jusque dans les forêts de l'intérieur, bravant la dent des ours et les crochets des serpents a sonnets. . . . Depuis cette époque, le zèle de M. Lorquin ne se ralentit pas, au contraire, ayant plus de loisirs, il entreprit des voyages dans des régions inexplorées: il alla visiter les montagnes du nord, pénétra fort avant dans l'est et se dirigea plus tard chez les Apaches, jusqu'à Los Angeles en Sonora. . . ."

IV. Hans Herman Behr (1818-1904)

Dr. Behr was a physician and naturalist-extraordinary. He was a friend of von Humbolt, who urged him to go to Australia in 1844 to study the bushmen as well as to collect insects and plants. He spent four years in the Indo-Australian region collecting and studying. No sooner had he returned to Germany in 1848 than he sailed for Brazil and the other South American countries. From there he journeyed to the Philippines and lived in Manila for two years. He arrived in San Francisco in 1851, and spent the rest of his life there. Among others, he described one butterfly that now is placed in the genus *Cercyonis*.

"*Satyrus boopis*"

1864 — Proceedings of the California Academy of Natural Sciences, [ser. 1], 3:164.

First, let me point out that Behr may have had confused *oetus* and *silvestris*, and that the "three allied species" are *sthenele*, *boopis* and "*silvestris*". It was not until Edwards rediscovered the types of *silvestris* in the late 1880's that the definition of the name became clear. Second, Behr considered material that later was named *gabbii* to be typical of *ariane*. Thus the misidentification of typical *ariane* probably led him to re-describe the taxon. Unfortunately, full proof of this is impossible since Behr's types were destroyed in the San Francisco earthquake and fire of 1906. The nearest thing to a type that exists is specimens sent to Edwards and Strecker by Behr bearing Behr's identification. These are not types in any sense of the word. Strecker considered his specimens from Behr to be the types. There is absolutely nothing in the letters written by Behr to Strecker that purports them to be such.

Behr stated clearly that his original material came from Contra Costa County. Thus a specimen from that county should be made the neotype. When this is done its point of capture may be taken as the type locality.

SUMMARY

alope Fabricius, 1793, type lost; type locality vicinity of Burke-Screven-Bulloch counties, Georgia.

ariane Boisduval, 1852, type at the United States National Museum; type locality, Tuolumne County, California.

boopis Behr, 1864, type lost; type locality, Contra Costa County, California.

nephele Kirby, 1837, type lost; type locality, vicinity of St. Josephs Island, Ontario, Canada.

- oetus* Boisduval, 1869, type at the United State National Museum; type locality, "Californie".
- pegala* Fabricius, 1775, type at The University, Glasgow, Scotland; type locality is vicinity of Charleston, South Carolina.
- sthenele* Boisduval, 1862, type at the United State National Museum; type locality, San Francisco, California.

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SATYRIDES.

58. SATYRUS ARIANE.

Alæ nigro fuscae; anticæ utrinque oculis duobus atris, pupilla alba iride fulvo; posticæ subtus strigis duabus undulatis obscuris, ocellis sex plus minusve obsoletis.

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ANNALES

Port et taille de notre *Phædra*. Dessus des ailes d'un brun-noirâtre. Celui des supérieures avec deux yeux noirs pupillés de blanc, à iris un peu plus pâle; celui des inférieures avec un œil plus petit, souvent précédé d'un autre petit œil sans prunelle. Dessous des ailes également brun, avec des hachures plus obscures, les yeux des premières ailes entourés d'un iris fauve, précédés d'une ligne transversale brune, et suivis près de la frange de trois lignes très fines, parallèles; celui des secondes ailes traversé au milieu par deux lignes brunes sinueuses, suivies d'une rangée irrégulière de six petits yeux noirs, à pupille blanche et à iris fauve, groupés trois par trois, et plus ou moins bien marqués. Femelle beaucoup plus grande que le mâle; les yeux des ailes supérieures grands, cerclés de jaune-fauve en dessus comme en dessous; les petits yeux du dessous des ailes inférieures beaucoup moins visibles que dans les mâles.

Se trouve communément dans les forêts. Ce Satyre se place entre notre *Phædra* et l'*Alope* des Etats-Unis.

59. SATYRUS STHENELE.

Alæ dentatæ fusæ ; anticæ ocellis duobus nigris pupilla alba ; subtus cinereæ, ocellis anticarum iride fulva ; posticæ fascia media angulata ocellisque duobus analibus.

Port et taille de nos plus petits individus de *Fauna*. Dessus des ailes brun, avec la frange d'un gris-cendré, entrecoupée de noir; celui des supérieures avec deux petits yeux noirs à prunelle blanche; celui des inférieures sans taches. Dessous des ailes d'un gris-cendré, plus foncé à la base; celui des supérieures avec les deux yeux plus grands et cerclés de jaune-fauve; celui des infé-

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rieures traversé par une large bande brune anguleuse, et marqué vers l'angle anal de deux petits yeux noirs à prunelle blanche. Femelle un peu plus grande que le mâle, ayant les yeux des ailes supérieures cerclés de fauve en dessus comme en dessous.

Beaucoup plus rare que le précédent.

LÉPIDOPTÈRES DE LA CALIFORNIE.

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62. *Satyrus Cetus*, Boisd.

Alæ supra fusæ ; anticæ ocello unico ; subtus : anticæ ocellis duobus pupillatis iride fulva ; posticæ sub-cinereo viriegatæ ocellis duobus analibus minutissimis.

Beaucoup plus petit que notre *Fauna* dont il a le port. Le dessus des ailes est brun, avec un petit œil noir non pupillé, vers le sommet des supérieures. Le dessous de ces mêmes ailes est un peu plus pâle, avec deux yeux noirs, pupillés de blanc, à iris fauve; celui des inférieures est un peu plus obscur, très légèrement ondé de grisâtre avec deux petites lignes transversales noirâtres en zigzag; outre cela il y a vers l'angle anal sur une petite bande noirâtre deux petits yeux noirs pupillés de blanc.

La femelle se distingue du mâle en ce qu'elle offre quelquefois en dessus deux yeux à iris un peu fauve.

Le mâle a aussi pour caractère, sur ses premières ailes, un épi oblique de couleur un peu plus obscure que le fond.

Il se trouve dans les lieux rocailleux des montagnes en juillet.

SATYRUS BOOPIS Behr.

Sthenele similis at limbus non tessellatus, sed linea transversa distincte partitus et feminae ocelli alarum superiorum in fascia dilutiori positi. Alae sub-
tusdimidiatae pars radicalis brunnea, marginalis grisea, marginem versus brun-
nescens. Utraque marmorata, halone ocellorum in alis anticis solo excepto
dilutiori et concolori.

This *Satyrus* is the biggest of our Californian species, the male being nearly
double the size of the female of *S. Sylvestris*. I find this *Satyrus* in July in Con-
tra Costa, on the hills as well as on the plains. In regard to the diagnosis of
these three closely allied species, I would mention, that the presence or ab-
sence of one or two more or less distinct eye-marks, on the upper or under
side near the anal angle of the hind wings, is of no diagnostic importance.

Pegala. 223. P. N. G. alis dentatis, fuscis: anticis fascia rufa
ocelloque unico, posticis supra ocello, subtus sex.

Habitat in America. Mus. D. Hunter.

Magnitudo P. Semele. Corpus fuscum. Alae anticae
fuscae, fascia lata rufa, quae tamen margines haud
attingit. Ocellus utrinque unicus, pupilla alba.
Posticae supra fuscae, ocello atro, iride fulva pu-
pillaque alba, subtus variegatae, ocellis sex atris,
iride ferruginea pupillaque albida. Tres e his
ocellis ad marginem tenuiorem connati, quintus
maximus.

Variat interdum ocello primo et quarto obsoletis.

715. P. S. alis dentatis fuscis: anticis utrinque fascia *Alope*.
flava; ocellis duobus, posticis ocello supra
unico subtus sex.

Papilio *Alope*. Jon. fig. pict. 4. tab. 12. fig. 1.

Habitat in India Dom. Francillon.

Corpus medium, fuscum. Alae anticae con-
colores, fuscae fascia lata, abbreviata, flava
& in hac ocelli duo atrii pupilla alba striga-
que postica atra. Subtus obscurae, fusco ir-
roratae ocellis sex pupilla alba.

NOTICES

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LIVING PUPAE of Hyalophora gloveri, H. cecropia and A. polyphemus for sale. 25 cents each. Jim Oberfoell, Bowman, N. Dakota.

WANT living Cymothoe coccenata, M. H. Ross, Div. Cancer Embryology, Biochem. Research Foundation, Newark, Delaware.

WANT Papilio zelicaon living stock, females or pupae. Will pay for field work or stock. C. G. Oliver, Educational Services, Inc. 108 Water St., Watertown, Mass. 02172.

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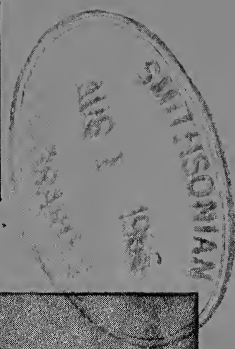
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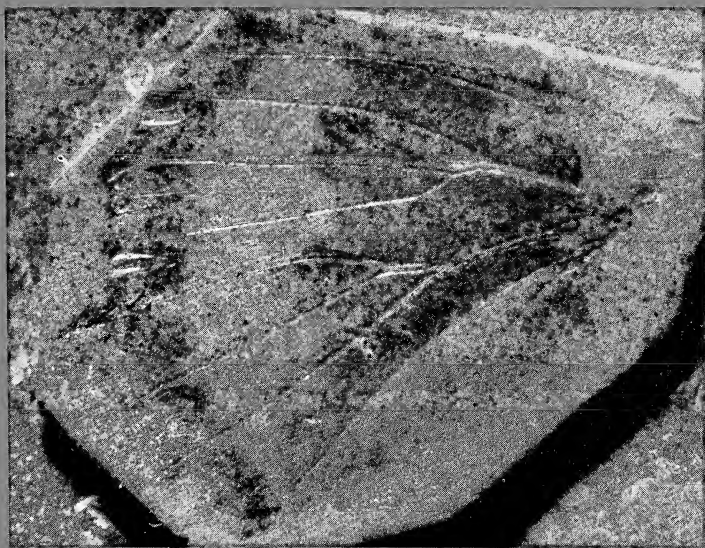
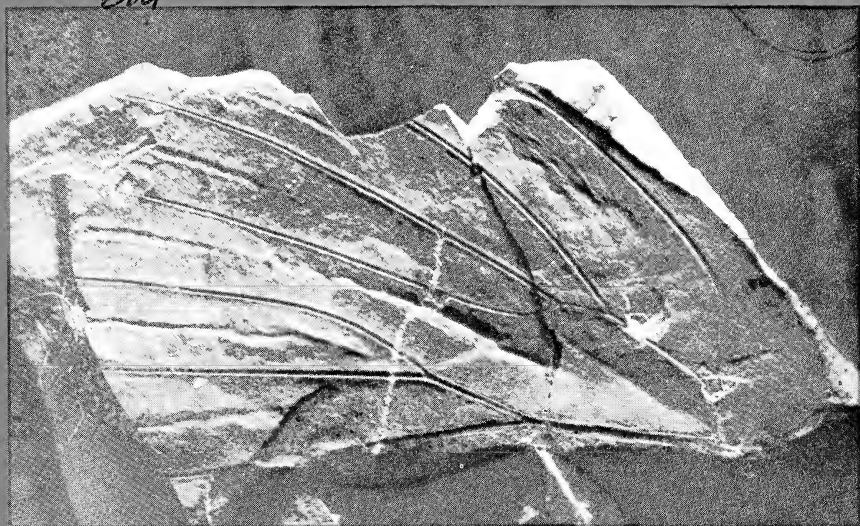
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TERTIARY NYMPHALID BUTTERFLIES
AND SOME PHYLOGENETIC ASPECTS OF SYSTEMATIC
LEPIDOPTEROLOGY
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MOST ZOOLOGISTS AND GEOLOGISTS agree that the phylogeny should represent evolutionary relationships between various organic groups, and that the genuine test of validity for any phylogenetic construction must be based on evolutionary data from different time periods. With a few exceptions, all neozoo-logical constructions poorly express the real phylogeny in the considered groups. Rather, they show primarily immediate inheritance — successive transitions between forms that live at the same time, the recent epoch. What is detected stage by stage is the provisory origin of the groups of various taxonomic rank. And however rich may be the material, however deeply it may be studied, one of the fundamental phylogenetic and evolutionary problems must always be left unsolved by the *neozoologist* — that of the direction of evolution.

Recent Rhopalocera are one of the most studied insect groups. Only the most remote areas of Asia and South America are able to supply the Lepidopterists of today with any important new finds. The great amount of material, accumulated by numbers of student generations, has been subjected to phylogenetic interpretation by numerous authors. In the course of study, various characters and groups of characters were considered. But in spite of good, and sometimes excellent, knowledge of these insects in almost every aspect, the problem of their basic phylogeny still remains open.

The key to this problem must be sought in fossil remains. Yet among the fossil Lepidoptera, imprints of Rhopalocera are exceptionally rare even though their body seems to be strong enough for good preservation in deposits of various types. One possible explanation for the rarity of butterfly finds is that the smaller quantity of Rhopalocera, compared to all the various groups of Heterocera, decreases the probability of finding their remnants.

Taking into account the described difficulties of lepidopterological phylogenetics that arise from the lack of fossil material, it is easy to imagine the value of each paleontological find in this group. The study of such rarities, perhaps not of particular interest for a geologist, is extremely important for a student of Lepidoptera. That is why I undertook with great joy the study of materials (imprints) that were kindly forwarded to me from the Paleontological Institute, Academy of Sciences, U.S.S.R. (Moscow).

Described material has been found in Karagan (Miocene) continental deposits near Stavropol (North Caucasus), in a locality Vishnevaya Balka (Cherry Ravine) which is abundant with insect imprints. Insect-containing layers from this area have been discovered in 1938 by B. F. Kaspiev (1939), and faunistically characterized in 1939 by B. B. Rohdendorf.

Kozhanchikov described *Xyleutites miocenicus* in 1957 from these deposits. Insect-containing layers, as determined by B. F. Kaspiev, are connected with upper horizons of the Karagan stage where fragile rocks alternate with gray sandy clays. Taphonomically* studied pieces are characterized by very high exactness that is the result of the fine grain structure of the containing rock. On the other hand, the high fragility of the rock caused the fragmentation of all pieces, and in the material studied no complete wings were found. Yet the venation pattern was sufficiently complete in one of the imprints to give it great diagnostic value.

Method of Treatment and Comparison of the Material

The mentioned lack of fossil Rhopalocera excluded any possibility of comparison of the considered specimens with corresponding specimens from other deposits and different ages. The only material which served for comparative purposes were specimens of recent species. In order to increase the objectivity, comparisons have been made not with the wings of recent butterflies, but rather their impressions on plasticine. The method involves the pressing of separated wings into a plasticine block. It may be done by a press shown in Figure 1, or by metal or glass plates. In order to prevent the plasticine block from sticking to the plate or press, sheets of glassine paper are placed between the block and other parts of this system. These sheets are re-

*For definition of "taphonomy" see I. A. Efremov (1950).

moved after use. After taking out the impressed wing, a very exact impression of the veins remains inscribed in contour on

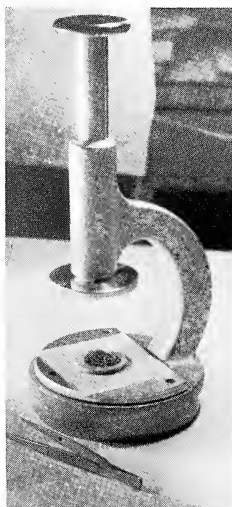


Fig. 1. Press used to obtain plasticine block impressions.

the plasticine block. On these impressions, however, the veins turned out somewhat thicker than in either the wing that was pressed, or the geological imprint. It may be that as a result of pressure, the veins are somewhat deformed and increase their surface area of contact with the plasticine block. Under the action of pressure, some wing scales are impregnated into the block surface; this, to a certain degree, also preserves the color and wing-pattern on the imprint. Though this method has as its main deficiency the loss of the treated wing, it allows a proper comparison: geological and artificial imprints, rather than imprints and actual wings. The described method seems to be more objective as the venation looks quite exact on the imprints; it is not covered with scales of tousled hairs. As to the loss of material, here two points must be taken into account. First, collecting in the field, the Lepidopterist often collects specimens whose condition is too poor for the collection, but which are suitable to produce imprints. Second, usage of even material from the museum collection for this purpose is, I strongly believe, completely justified by the importance of the task.

It is interesting to begin the comparison with a biometric study. But in all specimens the distal part of the wing is absent, so until additional data is available, the absolute size of these fossil wings must be measured using an approximation. For good accuracy, statistically, a series of material would have been needed. However, it is possible to state now that their size is comparable with recent representatives of *Vanessa*. In both specimens the proximal part of three vein systems is well preserved, which makes it possible to obtain the following measurements: (Figure 2)

1. D_1 — distance between base of M_2 and anastomosis of M_1 and R
2. b — distance between bases of C_1 and C_2
3. c — distance across the central cell between the bases of $M_3 + C_1$ and M_1
4. c_1 — Same as c except measured between R and C_2
5. d — distance between bases of S and R

A review of lengthy series of recent material in this group gave hope of obtaining reliable data for these measurements,

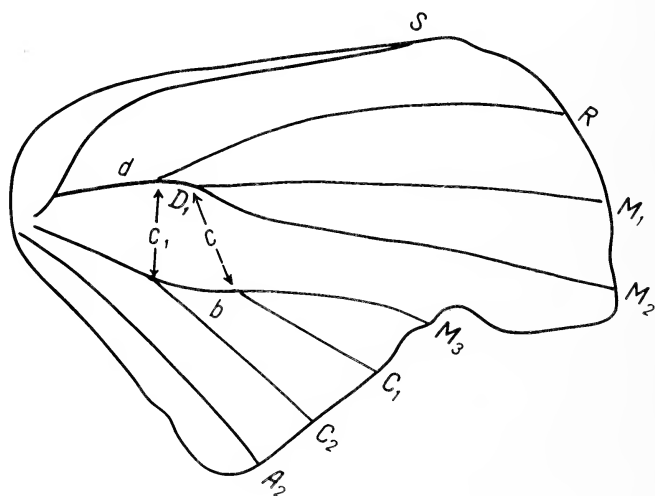


Fig. 2. Venation of *Vanessa karaganica*, n. sp.; definition of measurements used in comparisons.

though it must be noted that venation knowledge of recent *Rhopalocera* is still at a very low level in both the resultative and methodical senses. Due to the lack of detailed knowledge of the wing venation of recent butterflies, it is difficult to choose reliable characters in the venation for the purpose of paleontological and comparative-morphological survey.

DESCRIPTION OF A NEW FOSSIL SPECIES:

Family: *NYMPHALIDAE*

Swains. Phil. Mag., Ser. II, Vol. I: 187 (1827);

Westw. Genera Diurn. Lep.: 143 (1852)

Genus: *VANESSA Fabricius*

Illiger Mag. f. Insektenkunde, VI: 281 (1807)

Vanessa karagantica, Paleontologicheskii Journal (Moscow),
1965, 4:97-99 (In Russian). Nekratenko

Holotype: Paleontological Institute, Academy of Sciences of U.S.S.R., No. 254/2936a; Stavropol, North Caucasus, Vishnevaya Balka, Karagan horizon of Miocene. (Figure 3)



Fig. 3. Holotype of *Vanessa karagantica*, n. sp.

Diagnosis: By venation, type of wing-pattern and habitus, it is closely related to the recent *Vanessa urticae* L., and differs from the latter by the smooth shape of the termen, without sharp projections or teeth; the most distal point of the dark basal area lies in the cell between M2 and M3 (fig. 3a).



Fig. 3a. Artificial imprint of *Vanessa urticae* L. on plasticine.

Description and Comparative Notes: The central cell is not closed. Venation is typical for the genus *Vanessa*. In comparison with *Vanessa urticae* it is easy to determine that the considered imprint has been made by the left wing with the underside facing the observer. In *Vanessa urticae*, on the upper side, the dark basal spot is limited by the vein M₂; on the underside it occupies the entire basal part of the wing. On the described specimen, several dark spots are found between the basal spot and the marginal elements of the pattern. These spots, mostly between S and R, but also between M₁ and M₂, have not been observed in any artificial or natural variation of *Vanessa urticae*. Comparison of this pattern with the pattern of *Standfuss aberatio*s makes it likely that we are dealing with a "hot" form, close to ab. *ichnusa* or *ichnusoides*. Perhaps this last is of paleogeographical importance. These "hot" forms, by the way, are characterized by a more smoothly shaped termen than in the formal forms.

If additional material of fossil *Vanessa* becomes available, there will be chance to carry out a comparative survey of the pattern, which is most interesting in connection with the prototype concept of B. N. Schwanitsch (1949—see references). In the present case it is possible to state that the strial system of the forewing is continued in the hindwing in ancestral forms like *Vanessa karaganica*. The movement of this strial system in the proximal direction is culminated by its full junction with the basal system, giving rise to the dark basal field.

Morphometric data: $D_1=1.5$ mm, $b=2.5$ mm, $c=4.0$ mm, $c_1=3.5$ mm, $d=4.0$ mm.

Remarks: An impression of the incomplete hindwing, oriented to the right hand, on fine grain light shale. On the impression the following veins are clearly visible: P, S, R, M_1 , M_2 , in their entire length; M_3 , C_1 , C_2 and A_2 are missing the outer one-fourth of their length.

Occurrence: Upper Miocene, Karagan; North Caucasus, Stavropol Elevation.

Material: Holotype only.

NOTES ON A SECOND FOSSIL SPECIES

Genus *PYRAMEIS* Huebner (?)

Material: Paleontological Institute, Academy of Sciences, U.S.S.R. (Moscow), No. 254/2753, Stavropol, North Caucasus, Vishnevaya Balka. Negative imprint and fragments of positive imprints of hindwing. Impressions on fine grain flinty slate. Distal part of the venation was not preserved. On the imprints traces of single scales are clearly visible. The color of the piece is dark brown. See Figure 4.

Similar venation is found in all large representatives of the group *Vanessidi*. The comparison of this imprint with artificial plasticine imprints of major recent species shows its close relation to the genus *Pyrameis* Hbn., and in the range of this genus to *P. cardui* L.

Measurements have been made by the method shown in Figure 2 and the obtained data compared in the following table. For all recent species the mean sizes of ten specimens are given, except for *P. virginiensis*, of which only one example was available.

The study of the venation of a single specimen will not give a reliable indication of the species to which this specimen belongs. This is due to the incomplete knowledge of venation as a

TABLE 1.

	D ₁	b	c	c ₁	d
<i>P. fossilis</i> (nomen conditionalis)	1.5	3.5	4.5	4.5	4.0 mm.
<i>P. cardui</i> L.	1.0	3.0	4.5	6.0	4.5 mm.
<i>P. atalanta</i> L.	3.0	4.0	4.0	5.0	4.0 mm.
<i>P. indica</i> Hrb.	5.0	3.5	5.0	5.5	5.0 mm.
<i>P. virginensis</i> Dru.	0.0	3.0	5.1*	4.0*	4.0 mm.

*Distance across the central cell between anastomoses of R, M₁ and the base of C₁ and C₂.

taxonomic character in recent species. Nevertheless, on the basis of a morphometric investigation I believe that the considered specimen is closer to *Pyrameis* than to *Vanessa*. Among all *Pyrameis* considered, this species is the closest to *P. cardui* L. In my opinion, the material here is not complete enough for a new species description, but some preliminary theories will be presented.

The genus *Pyrameis* contains a group of very "eurybiont" species, among which *P. cardui* is noted as the most widely distributed. Because of its great adaptive range, this butterfly is

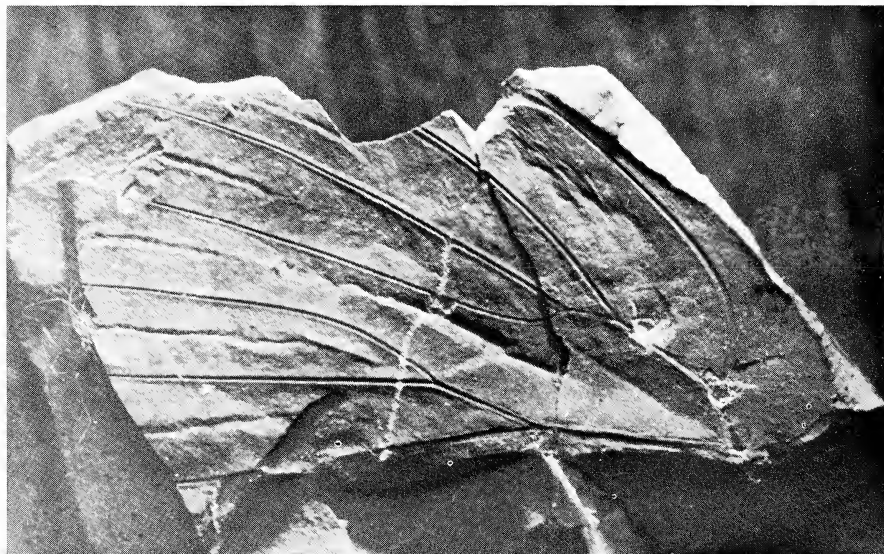


Fig. 4. Fragment of hindwing, *Pyrameis fossilis* (nomen conditionalis).

found nearly throughout the whole globe. It is absent just in the polar areas and, it seems to me, in South America. A. A. Jachontov (1935) noted that there are no differences between specimens from cold and warm areas, with the exception of slight variation in color: "climate to a certain extent affected the wing coloration of them." If a series of *P. cardui* from different countries are placed in the same collection box, then even trained eyes will not recognize their geographic origin. The nine forms of *P. cardui* given by Stichel (1909) does not have any geographical basis and is probably due to the occurrences of butterflies developed in years of great climactic oscillations. As far as I know, they do not differ from each other in any way in venation. As for other species of this genus, they do not manifest so great a tendency to variation as we see in *Satyrus*, *Parnassius*, etc., though they are more local.

One of the causes of speciation is environment. Interacting with an organism in various ways, it gives rise to development of new forms, and to the decline of old ones, if they are eliminated by their narrow adaptive range. It is also known that geographical variation is the result of heterogeneity of environment over the species' range. In this way, temporal variability must be connected with environmental heterogeneity in time. It is natural to presume that a definite dependence exists between spacial and temporal variability. The most important point here is that an organism's variability is a function of its adaptive range, which evolves together with all other characters. This last seems to explain the various rates of evolution within a given taxonomic group and we can observe it by the fossil remnants of various ages. If large series of fossil Lepidoptera would become available, there can be no doubt that this question, important to both stratigrapher and evolutionist, would probably be answered as follows:

Organisms of little variability in time will manifest little variability in space, and vice versa.

With an organism in the sense of F. E. Zeuner (1943), we will assume a fast transition from the "phylogenetic stage" X to Y and a minor variation in the process of formation of the recent form Z. In this way, the given form after a period of major differentiations, gives no changes in the future, or at least changes so small that they do not affect the taxonomic position of this form. Such forms have been called *phylogenetic relics* by B. B. Rohdendorf (1959). It is possible that recent butterflies of the

genus *Pyrameis* are, thanks to their wide adaptive range, such phylogenetic relics that have colonized nearly the entire world.

It is also possible that study of variation in recent forms at various taxonomic levels will give insight into their formation and age. Such a study should be carried out based on complete and deep examination of recent material. And butterflies, in my opinion, are a most suitable subject for such a study.

The next question that may arise when fossil material is under consideration is the question of tempo in evolution of various organs and systems on the wing, as an anatomical unit. Study of our material suggests that time changes in the wing pattern occur more quickly than changes in venation. This, perhaps, may be explained by the fact that pattern in insects is a "younger" structure in comparison with venation. In this case we deal with phenomena much like those described by A. N. Severtzov (1936). This also relates to the previous thought expressed above, on the dependence between age and variability, but at the level of organs.

Acknowledgement: I want to express my thanks to the persons who have made this work possible: to Dr. B. B. Rohdendorf who kindly gave me the material for this paper, to Dr. A. I. Shevchenko for her kind criticism and important advice, and to Mr. Ronald Leuschner and Dr. William Hovanitz, without whose help it would have been impossible to print this paper in English.

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THE FEEDING OF COLORING MATTERS TO *PIERIS RAPAE* LARVAE

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INTRODUCTION

SINCE THIS PAPER IS CONCERNED with the feeding of dyes to the larvae of *Pieris rapae*, mention will be made of some of the work that has been done along similar lines with other insects.

The silkworm has been a favorite subject. Lombardi (1920) fed dyed leaves to the worms to time the retention of the leaf in the intestine. That aniline dyes were absorbed by the silkworm gut was mentioned by Goris and Muehleemann (1936). Jucci and Ponceveroni (1930) found that Berlin blue, safranin, gentian violet, methylene blue, Nile blue, neutral red, indigo carmine, alizarin, fuchsin, methyl orange, and other dyes did not show up in the silk. Only orcein migrated into the cocoon, while neutral red, Sudan III, methylene blue, and Nile blue migrated into the eggs. Campbell (1932) fed aqueous solutions of dyes to fourth-instar silkworms. Alternatively, fifth-instar worms were injected with measured volumes of the solutions. This interesting work will be referred to in the Discussion. An article by Edwards (1921) reviews attempts to produce colored silk by feeding dyes to silkworms and also will be referred to in the Discussion.

The selectivity of absorption of dyes by the midgut of *Machilis* (Thysanura) is shown by the fact that only fifteen of sixty-five dyes were taken up by the midgut caeca, and the uptake of several dyes by the midgut of various insects has been studied (Roeder, 1953). It was found by feeding dye-coated seeds to wireworms (Zacharuk, 1963) that the dyes most suitable for marking the living worms internally were Nile blue, rhodamine B, Sudan black B, brilliant cresyl blue, acridine orange N, coriophosphine O, and brilliant fat scarlet. External manifestation in the adult stage was prevented by the brownish-black integument

of the beetles. Also, various dyes (some mentioned in Discussion) have been fed to silverfish on ground wheat (Lindsay, 1940).

The literature as cited above suggested that certain dyes probably would be absorbed by the intestine of the *Pieris rapae* larva, but there is no real indication that a dye might appear on the resulting adult, especially superimposed on the conveniently white or off-white ground color of the wings. Therefore, the following experiments were made with the particular object of changing the color of the wings and the secondary objects of externally coloring the pupae, noting toxic effects, and making incidental observations on other effects of ingested dyes.

EXPERIMENTAL

1. REARING PROCEDURE

Thirteen females (collected at Flemington, N. J., on May 1, 1965) were confined in a glass jar (approximately a cylinder 3.5 inches in diameter and 5 inches in height) containing fresh cabbage leaves held in place by a wire screen over the top, and the jar was placed in an open window in direct sunlight. (Ordinary electric light from a 100 watt bulb close to the jar also was effective in stimulating oviposition.) The first day yielded about 280 eggs and the second day 105 eggs; only four butterflies remained alive at the end of the second day.

The larvae were kept in cardboard boxes (4.5 inches high by 9 inches square) with gauze windows (5.5 inches square) in the lids and were fed leaves peeled from refrigerated cabbage heads. As the larvae grew they were distributed among the boxes so that usually there were no more than fifteen per box by pupation. However, as many as 43 could be reared to pupation (to give 37 pupae all of which yielded adults) in a single box.

The control adults of the first brood were placed in a screen-covered cage (16 inch cube) in which they were exposed to fresh air and sunlight for a day to allow mating; then cabbage leaves (fresh each day) were hung up on the screen on the sunny side of the cage for three to four days to collect eggs. With 25 or more butterflies, hundreds of eggs were obtained in this manner (though production per female might be only on the order of 30 eggs since the butterflies were not fed). In this fashion four consecutive broods were reared during the experiments described below. Eclosion of the last brood was completed on Sept. 22, 1965.

In one case, new pupae were refrigerated at 1-3° C. for six days to delay the time of eclosion with no ill effects, and the 1 to 3-day-old larvae of the last brood similarly were refrigerated for two days because they could not be attended during this time.

Although really unnecessary, since photoperiod seems to have no effect above 20° C., the boxes were illuminated by electric light until 2 A.M. each morning to make certain that the pupae would not diapause. The room temperature varied from a low of 65° F. at night to a high of 90° F., and the relative humidity was always in the range 31-65%.

2. METHOD OF FEEDING DYES

At first, dyes in salt shakers were simply sprinkled onto the leaves at, very approximately, 2 mg./in.² leaf surface; in such cases the dye is listed as "100% of blend" in Table 1. However, the desirability of lowering the ingestion levels of the more toxic dyes as well as the extent of consumption of expensive biological stains suggested that the dyes be extended with an inert ingredient. Organic compounds were extended in experiments in which a mixture of 10% compound and 90% kaolin was fed to silkworms (Ginsburg and Cavallito, 1936), and pesticides customarily are extended with clays. It has been suggested that malachite green compounded with clay might be used in insecticides (Campbell, 1932).

Five possible extenders were considered: Celite (Johns-Manville Products), P-12 Davenite mica (325 mesh; Hayden Mica Co.), Hydrite UF kaolin (Georgia Kaolin Co.), "lanolized" talcum powder, and ASP 400 P aluminum silicate pigment (Minerals and Chemicals Philipp Corp.). The talcum powder was rejected because it was not easily wetted by water, and the kaolin was eliminated because it tended to cake up and was not delivered readily from a salt shaker. The other three candidates were fed to larvae (at about 2 mg./in.² leaf surface, applied to both sides of the leaf) as shown in Table 1. The aluminum silicate and the Celite seemed to have a "dehydrating effect" on the larvae in terms of appearance, for many of them shriveled up and died. Mica gave the best result, and its inertness to the larvae was demonstrated by the many cases (see Table 1) in which dye-mica blends allowed 90-100% yields of both pupae and adults.

The dye-mica mixtures were prepared by grinding thoroughly the dye and a portion of the mica with a mortar and pestle and then blending with the remainder of the mica by tumbling. The resulting blend was sprinkled, from a salt shaker, onto both sides

Table 1. Feeding of Coloring Matters to *Pieris rapae* Larvae.

Biolog. Stain, or Dye*	CI No.	% of Blend	Days Fed	Color Larvae	Yield Furax	Color Pupae	Yield Adults
<u>NITRO</u>							
Naphthol Yellow S*	10316	5	3-5	N	14/15	N	13/15
<u>MONOAZO</u>							
Janus Green B	11050	5	to 9	deeper green	0/15	-	0/15
Oil Scarlet 6G	12140	5	3-8	N	12/15	v. sl. pink	12/15
Citrus Red #2*	12156	5	5-9	sl. pink?	14/15	N	13/15
FD&C Red #4*	14700	100	4-7	sl. pink	5/7	N	5/7
Amaranth	16185	5	2-6	N	14/15	N	14/15
FD&C Yellow #5*	19140	100	5-9	N	7/7	N	7/7
<u>DIAZO</u>							
Bismarck Brown Y	21000	5	3-6	N	13/15	N	13/15
Bismarck Brown R	21010	5	3-5	sl. brown	15/15	sl. pink	15/15
Congo Red	22120	5	3-4	N	15/15	N	15/15
Brilliant Vital Red	23570	5	3-7	N	13/15	N	13/15
Trypan Blue	23850	5	3-5	sl. blue	15/15	N	15/15
Evans Blue	23860	5	4-5	sl. deeper grn.	13/15	sl. green?	12/15
Sudan III	26100	5	3-6	sl. pink	14/15	pink	14/15
Sudan IV	26105	5	3-4	v. sl. pink	15/15	pink	15/15
Sudan Black B	26150	5	2-4	bluish	15/15	greenish-blk.	15/15
"	"	5	6 (Note 1)	gray-grn.	9/20	deep blue	6/20
<u>DIPHENYLMETHANE</u>							
Auramine O*	41000	5	4-9	sl. yellow	9/15	yellow-green	6/15
<u>TRIARYLMETHANE</u>							
Victoria Green WB*	42000	5	to 4	N	0/15	-	0/15
Brilliant Green	42040	5	to 5	deeper green	0/15	-	0/15
Fast Green FCF	42053	5	3-6	deeper green	15/15	N	15/15
FD&C Blue #1*	42090	100	4-7	N	6/7	N	6/7
FD&C Green #2*	42095	100	4-9	N	7/7	N	7/7
Fuchsine Y*	42510	5	to 6	pink	0/15	-	0/15
Crystal Violet	42555	5	to 9	sl. bluish?	0/15	-	0/15
Aniline Blue	42755	5	3-6	sl. deeper grn.	15/15	N	15/15
<u>XANTHENE</u>							
Acridine Red	45000	5	5-13	deep pink	11/15	pink	11/15
Rhodamine B*	45170	100	5	pink	0/7	-	0/7
"	"	1	3-6	pink	9/10	sl. pink	9/10
Fluorescein*	45350	100	7	N	1/7	N	1/7
Uranine*	45350	1	2-4	N	15/15	N	15/15
Rose Bengal	45440	5	2-3	N	15/15	N	15/15

Table 1. (Continued) (part 2)

<u>Biolog. Stain, or Dye*</u>	<u>CI No.</u>	<u>% of Blend</u>	<u>Days Fed</u>	<u>Color Larvae</u>	<u>Yield Pupae</u>	<u>Color Pupae</u>	<u>Yield Adults</u>
<u>ACRIDINE</u>							
Acridine Orange	46005	5	3-6	N	2/15	orange-yellow	2/15
<u>METHINE</u>							
Nabor Brill. Red 6B*	48020	5	to 5	sl. pink?	0/15	-	0/15
<u>AZINE</u>							
Neutral Red	50040	5	4-7	pink	10/10	red	7/10
"	"	5	32 hrs.(Note 2)	pink	13/15	N to pink	12/15
Azocarmine G	50085	5	6-11	N	10/15	N	8/15
Azocarmine B	50090	5	5-8	N	11/15	N	9/15
Phenosafranin	50200	5	to 7	pink	0/15	-	0/15
Safranin, Bluish	50205	5	1-6	N	9/15	N	8/15
Safranin O	50240	5	to 7	pink	0/15	-	0/15
Naphthalene Red	50375	5	6-11	deeper green	13/15	N to violet	10/15
Indulin(Alc. soluble)	50400	5	5-10	N	13/15	N	12/15
Nigrosin(Water sol.)	50420	5	7-10	deeper green	7/15	N	7/15
<u>OXAZINE</u>							
Brill. Cresyl Blue	51010	5	3-9	bluish	15/15	violet	15/15
Gallocyanine	51030	5	6-10	sl. deeper grn.	11/15	N	8/15
Celestine Blue B	51050	5	6-11	sl. deeper grn.	13/15	N	10/15
Nile Blue A	51180	5	3-4	bluish	4/15	blue-green	4/15
"	"	1	4-9	bluish	13/15	blue	10/15(Note 3)
"	"	5	32 hrs.(Note 4)	bluish	13/15	blue	8/15
<u>THIAZINE</u>							
Methylene Blue*	52015	100	to 5	deeper green	0/7	-	0/7
"	"	1	3-7	deeper green	15/15	pale grn.-blue	15/15
Methylene Green*	52020	100	to 5	deeper green	0/7	-	0/7
"	"	1	3-5	sl. deeper grn.	14/15	sl. green	14/15
<u>ANTHRAQUINONE</u>							
Alizarin	58000	5	3-4	N	14/15	N	14/15
<u>INDIGOID</u>							
Indigo Carmine	73015	5	2-4	N	14/15	N	14/15

Table 1. (Continued) (part 3)

<u>Biolog. Stain, or Other</u>	<u>CI No.</u>	<u>% of Blend</u>	<u>Days Fed</u>	<u>Color Larvae</u>	<u>Yield Pupae</u>	<u>Color Pupae</u>	<u>Yield Adults</u>
<u>NATURAL ORGANIC COLORING MATTERS</u>							
Carmine (Alum Lake)	75470	5	3-5	N	15/15	N	12/15
Orcein	-	5	3-5	N	15/15	N	15/15
Paprika, imported	-	10	3-5	N	15/15	N	15/15
<u>INORGANIC COLORING MATTERS</u>							
Berlin Blue	77510	5	4-6	N	14/15	N	14/15
<u>NEUTRAL RED - NILE BLUE A MIXTURE</u>							
Neutral Red	50040	1					
Nile Blue A	51180	1	2 (Note 5)	blue	13/15	greenish-blue	12/15
<u>INDICATORS</u>							
Phenol Red	-	5	3-5	N	12/13	N	12/13
Brom Cresol Purple	-	5	2-6	N	14/15	N	14/15
Brom Thymol Blue	-	5	2-6	N	14/15	N	14/15
<u>EXTENDERS ALONE</u>							
P-12 Davenite Mica	-	100	4-6	N	5/7	N	4/7
Celite	-	100	6	N	2/7	N	0/7
ASP 400 P	-	100	4-8	N	3/7 (Note 6)	N	1/7
<u>CONTROLS</u>							
None	-	-	3-8	N	52/60	N	51/60
None	-	-	3-6	N	37/43	N	37/43
None	-	-	4-7	N	17/20	N	16/20

Notes

1. Larvae pupated 1-4 days after suspension of dye feeding.
2. Larvae pupated 3-6 days after suspension of dye feeding.
3. All but one adult failed to expand wings. There were only incidental failures to expand (up to 3 out of 15 specimens) in all other cases.
4. Larvae pupated 5-8 days after suspension of dye feeding.
5. Larvae pupated 4-6 days after suspension of dye feeding.
6. These pupae were dwarfed (12, 12, and 14 mm. in length vs. 17 mm. for normal pupae).

of each newly-added leaf at about 2 mg. blend/in.² leaf surface.

Feeding was begun when the larvae had attained a minimum length of 5 mm. in the case of pure dyes (100% of blend) or 17 mm. in all other cases; the final length is about 25 mm. In all but four cases (see footnotes in Table 1) feeding was continued to pupation. That the dyes were being ingested was shown in nearly all cases by the color of the excrement.

3. EXPLANATION OF TABLE 1

All the coloring matters except the paprika (a kitchen item) were obtained from the National Aniline Division of the Allied Chemical Corp. Dyes (commercial colorants) are identified by an asterisk, as shown at the head of the column in the table. Except for the three indicators and the paprika, all the others are biological stains and are listed and described in the "National Biological Stains and Indicators Price List", 1964. In the present case, dyes are distinguished from biological stains on the basis of how they were obtained; for example, methylene blue happened to be procured as a dye sample, but it is also sold as a biological stain. For convenience, the coloring matters in general are apt to be called "dyes" elsewhere in this paper. The chemical structures of all the materials with a CI (Colour Index) number are given in the well-known Colour Index.

In the column headings, "% of blend" means the weight-% of dye in the dye-mica blend, and "days fed" indicates the time from the beginning of dye feeding to pupation (in all but four cases) and is, of course, a range due to differences among individual larvae. In the yield columns, 14/15, for example, means that 14 pupae or adults were obtained from the original 15 larvae. Under "Color", N means normal, as in the control group.

Following the Colour Index system, the dyes are grouped into chemical classes in the table.

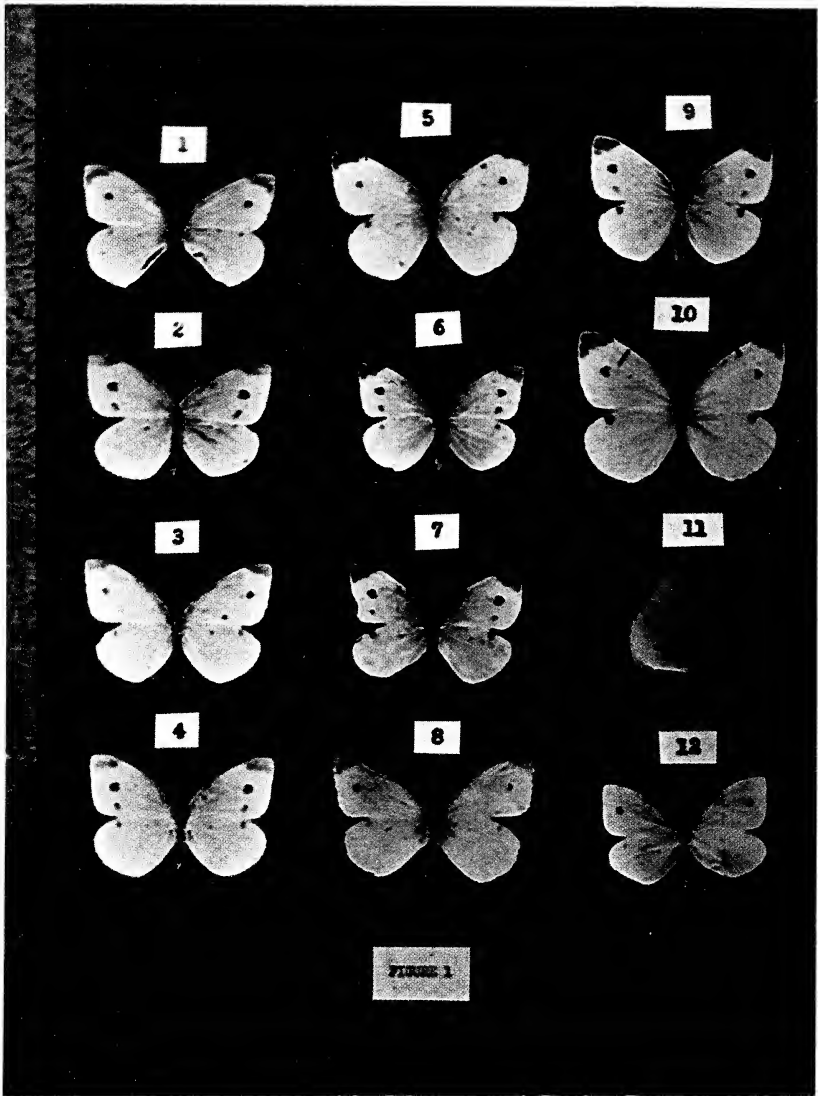
RESULTS AND DISCUSSION

1. VITAL STAINING RESULTS

a. LARVAE

It should be noted that the judgment of external color was difficult because of the presence of mica-dye blend clinging to the integument.

Of the 56 coloring matters fed, 24 (four at 100% of blend, the rest at 5%) gave no color in larvae or pupae (or adults), and most of these allowed high yields of uncolored adults. Eight dyes (one at 100% of blend, the rest at 5%) were more or less doubtfully visible in the larvae and were not seen in the pupae. Of



the eight dyes (at 5% of blend) so toxic or repellent that no pupae were produced only one did not give a real or suspected color in the larvae. In only two cases did color (orange-yellow, which is difficult to see in the green larvae, or very pale pink) appear in the pupae without being detected in the larvae. Only 14 dyes (three at 1% of blend, the rest at 5%) appeared in both larvae and pupae.

These results indicate that, in general, toxic dyes impart external color to larvae, which seems reasonable since toxicity should require absorption, and color will seldom appear in the pupa if it is not seen in the larva. Of the fifty-six dyes tried, thirty-one (including the two that gave colored pupae with no color having been noted in the larvae) gave real or suspected external colors in the larvae.

b. PUPAE

Results were more definite than with larvae because the powder-covered larval skin was shed to give an uncontaminated pupa.

Thirteen dyes at 5% of blend and three dyes at 1% gave external pupal colors ranging from faintly tinted to strongly colored. The following nine dyes gave conspicuous colors: Sudan black B (greenish-black), Sudan III (pink, especially on abdomen), Sudan IV (pink, especially on abdomen), auramine O (yellow-green), acridine red (pink), acridine orange (orange-yellow), neutral red (red), Nile blue A (blue), and brilliant cresyl blue (violet).

c. ADULTS AND THEIR EGGS

The effect of the dyes on external color (body, eyes, and wings) may be simply stated — Only Nile blue A and neutral red, discussed separately below, appeared externally in the adults.

EXPLANATION OF FIGURE 1 (cf. Table 1)

1. Male. Neutral red (5% of blend) fed 4-7 days.
 2. Female. Neutral red (5% of blend) fed 4-7 days.
 3. Male. Neutral red (5% of blend) fed 32 hours.
 4. Female. Neutral red (5% of blend) fed 32 hours.
 5. Male. Nile blue A (5% of blend) fed 3-4 days.
 6. Female. Nile blue A (5% of blend) fed 3-4 days.
 7. Female. Nile blue A (1% of blend) fed 4-9 days.
 8. Male. Nile blue A (5% of blend) fed 32 hours.
 9. Female. Nile blue A (5% of blend) fed 32 hours.
 10. Male. Neutral red (1% of blend) and Nile blue A (1% of blend) fed 2 days.
 11. Male, underside. Neutral red (5% of blend) fed 4-7 days.
 12. Female. Celestine blue B (5% of blend) fed 6-11 days.
- (Size Reference: Length forewing of specimen no. 10 is 21 mm.)

There is reason to suspect (see below) that Sudan black B may be transmitted to the eggs. This dye did give strong internal color, and some more or less intense internal coloration may have occurred with the other six dyes that gave strongly-colored pupae. Though larval feces were fluorescent, fluorescein and uranine failed to give external fluorescence in larvae, pupae, or adults.

The dyes had no obvious effect on the black markings of the wings, which are highly variable. There was a tendency in the last brood for the lower female forewing spot to be almost or quite missing whether or not dyes were fed. An example is shown in Figure 1 for celestine blue B. Curiously, the apical markings also are missing in this case.

d. CHEMICAL STRUCTURE AND ABSORPTION

In considering the dye-feeding results with wireworms, Zacharuk (1963) was unable to generalize vital staining properties in terms of dye structure. Monoazo, diazo, diphenylmethane, acridine, azine, thiazine, and thiazole types were all absorbed. The best dye for vital marking of wireworms was Nile blue (an oxazine, and the next best was rhodamine B (a xanthene).

In the present work (Table 1) dyes among the diazo, diphenylmethane, xanthene, acridine, azine, oxazine, and thiazine types were absorbed to give more or less strongly colored larvae and pupae, while toxic dyes (yielding no pupae) were found in the monoazo, triarylmethane, xanthene, methine, azine, and thiazine classes. These results are suggestive or qualitative only, of course, because dosage was not controlled in these experiments, which constitute essentially a screening program.

Because of the success of Nile blue A, three more oxazines were tried; none colored the adults, but brilliant cresyl blue gave strongly violet pupae. Similarly, following the success of neutral red, eight more azines were tested; some were quite toxic, while among the others only naphthalene red gave a hint of color in the pupa. Thus, among the azines and oxazines screened neutral red and Nile blue A were uniquely effective.

Methylene blue and Sudan III were absorbed by silverfish (Lindsay, 1940), and, in further agreement with the present work, carmine was not absorbed. Congo red, which was not absorbed by the *Pieris rapae* larvae, has been found not to be absorbed by the midgut of adult *Deilephila* (Roeder, 1953).

e. INDICATORS

Insects (Thysanura) have been fed indicators to show the pH of different regions of the gut (for example, Modder, 1962). In the case of wireworms (Zacharuk, 1962) phenol red stained the gut contents deep red, suggesting a pH above 8.4. In the present work, the excrement of larvae fed indicators was yellow-orange (pH 6.8-8.4) with phenol red, yellow-orange (pH less than 6) with brom thymol blue, and deep wine-red (pH above 6.8) with brom cresol purple. These results plainly are contradictory in defining the pH of the excrement. As seen in Table 1, the indicators had no efficacy as vital stains.

2. TOXICITY

The fact is that the larvae which were fed "toxic" dyes died before pupating, but it is difficult to distinguish between poisoning and starvation because, as has been pointed out (Ginsburg and Granett, 1935), some organic compounds may be repellent to larvae while others may be truly toxic. Injection might be necessary to make the distinction. In any event, rhodamine B, methylene blue, and methylene green were 100% fatal at 100% of the blend but harmless at 1%. Methylene blue, incidentally, in the nutrient medium is toxic to *Drosophila* larvae (David, 1963). Fluorescein was very toxic at 100%, but its sodium salt (uranine) was harmless at 1%.

The following dyes (at 5% of blend) were 100% fatal: Janus green B, crystal violet, brilliant green, Victoria green WB (malachite green), fuchsine Y, Nabor brilliant red 6B, phenosafranin, and safranin O. The following dyes (also at 5%) showed limited toxicity: Sudan black B, auramine O, acridine orange, safranin bluish, nigrosin, azocarmine B, azocarmine G, naphthalene red, Nile blue A, celestine blue B, and gallocyanine.

The theory that basic dyes are especially toxic to the animal organism is consistent with the results of Campbell (1932) with silkworms, e.g. malachite green, safranin bluish, brilliant green, and crystal violet were particularly toxic. Also, it was noted in other experiments with the silkworm (Ginsburg and Cavallito, 1936) that water-insoluble organic compounds are apt to show higher toxicity if they bear primary amino groups.

The eight dyes listed above as 100% fatal at 5% of blend all bear amino groups with substituents no larger than 2-chloroethyl. Of the eleven dyes that showed limited toxicity at 5% of blend, eight have amino, dimethylamino, or diethylamino groups, and the other three have disubstituted amino linkages. These facts agree with the generalization that amino and substituted amino groups

contribute to toxicity. However, many of the dyes harmless at 5% of blend, e.g. Bismarck brown Y and brilliant cresyl blue, are well endowed with amino and dialkylamino groups. Also, amino groups were not necessary for the absorption of dyes; of the nine dyes strongly manifested in the pupae two (Sudan III and Sudan IV) have only azo and hydroxyl groups.

Triarylmethane dyes are noted for toxicity, but two (see Table 1) had no effect even at 100% of blend (perhaps because they bear no amino, dimethylamino, or diethylamino groups).

In conclusion, no generalization is apparent except that the toxic dyes had amino or substituted amino groups but dyes with similar amino groups were not necessarily toxic.

Incidentally, some interesting deformities were noted in adults fed the partly-toxic (under the conditions) safranin bluish. These were (1) a dwarfed female (15 mm. forewing), (2) a female with deformed forewing, and (3) a male with eyes undeveloped and antennae, prolegs, and adult palpi missing.

3. DYES OF PRINCIPAL INTEREST

a. NEUTRAL RED

Neutral red was the only dye of several tested that changed the external color of the silkworm (Campbell, 1932), and it was said not to be toxic to silkworms (Edwards, 1921) although it gave 80% mortality among wireworms vs. 20% for a control group (Zacharuk, 1963). The red color persisted for more than 40 days in wireworms when dye feeding was suspended but was eliminated within 18 days when silkworms were fed undyed leaves (Edwards, 1921).

In the present work, loss of dye from the larvae when dye feeding was suspended was indicated. The most effective way, therefore, to produce colored adults with a minimum of possible toxic effect may be to feed the dye only during the last two days or so of larval life. In the case of silkworms it was only necessary to feed the dye during the fifth instar to produce red cocoons (Edwards, 1921).

With *Pieris rapae*, the silken pupal girth was slightly pink. In the adult, the wing membrane of heavily-colored specimens was colorless, while the scales on wings and abdomen were pink (or, more accurately, violet-pink). The contents of the eye were dark-red instead of the normal dark-brown. As seen in Figure 1, increasing neutral red content in the butterfly is seen first in the eyes and abdomen (specimens no. 3 and 4) and later more and more intensely in the wings (nos. 1, 2, and 11).

The neutral red used in this work was the chloride (see Colour Index for formula) and was specified by National Aniline to have 70% minimum strength and 1.0% maximum water-insoluble content.

b. NILE BLUE A

This was shown by Zacharuk (1963) to be the most suitable dye for marking living wireworms internally and imparted more color (to fat) and was retained longer than neutral red (which stained tissues in general).

In the competitive experiment in which 1% each of neutral red and Nile blue A were present in the blend (see Table 1 and Figure 1, specimen no. 10), the adults showed only the influence of Nile blue A, i.e., they ranged from uncolored to pale-blue with blue-green eyes.

Nile blue A adults were colored internally as well as externally, the contents of the abdomen being blue and gray-blue.

The Nile blue A used in this work was the sulfate (see the Colour Index for the formula of the corresponding chloride) and was specified by National Aniline to have 70% minimum strength.

c. OTHER DYES

Brilliant cresyl blue seems promising for marking pupae (violet) because it gave strong coloration and was not at all toxic at 5% of blend.

Sudan black B was assimilated into the fat body of wireworms, coloring it greenish-blue to black (Zacharuk, 1963), and is a fat stain used for lipids (Roeder, 1953). In the present work it gave butterflies with no external color but whose abdomens were seen to be gray-blue internally on teasing open under the microscope. Some of the eggs laid by a group of females including some fed Sudan black B as larvae were blue-gray in color and produced pale blue-gray larvae (as opposed to very pale greenish in the normal case), but this suspected carry-over of the dye into the eggs needs confirmation.

CONCLUSION

It has been suggested (Campbell, 1932) that the staining of silkworm epidermis by neutral red might be applied to the indelible marking of insects for experimental purposes. The present work with *Pieris rapae* discloses dyes useful in marking larvae and pupae as well as adults (in the case of neutral red and Nile blue A). Neutral red seems particularly suitable for staining the wings of butterflies by means of feeding the dye, conveniently blended with mica or perhaps another extender, to the caterpillars.

Aside from the use of the dyes as a convenient marker, it might be of interest to note the effect of the colors on the behavior of adults. For example, *Pieris napi* males respond differently to the white form vs. the yellow form females (Petersen, Tornblum, and Bodin, 1932), and in line with this it might be interesting to observe the relative attraction of normal males to pink or blue females. Also, the concentration of neutral red, for example, in the eye might alter the response of the butterfly to various colors; red-eyed females might show different color preferences for oviposition than normal females (see Hovanitz and Chang, 1964). Many other experiments suggest themselves.

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SYSTEMATICS AND LIFE HISTORY OF SATURNIA (CALOSATURNIA) ALBOFASCIATA IN CALIFORNIA (SATURNIIDAE)

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Saturnia (Calosaturnia) albofasciata (Johnson, 1938) is unquestionably the least known saturniine of the United States. The species has received virtually no mention in the literature since its relatively late discovery and until 1950 was represented in collections by only three specimens. It is safe to say that even most North American lepidopterists are totally unaware that this moth exists.

Our interest (Hogue and Sala) in the species was originally aroused by a specimen in the Los Angeles County Museum (#9 below). Correspondence with J. W. Johnson during our earlier investigations of *Saturnia walterorum* (Sala & Hogue, 1958) made us aware that there existed a late fall saturniine in our local area that we knew nothing about. On the basis of the scant information then available we speculated on the life cycle of *S. albofasciata*. Our speculative conclusions proved to be valid in general. The life cycle is what makes this moth so interesting to us. No other saturniine in North America has such a cycle—spending the winter as an egg, spinning a cocoon and passing the summer months as a pupa and emerging and completing the imaginal stage just prior to the oncoming winter. The hemileucines have a cycle like this almost without exception but, of course, are not closely related to the saturniines.

RECORDS⁵

Type Material

The species was originally described (Johnson, 1938. Bul. Brook. Ent. Soc. 33:128-130) from two adult females as follows:

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⁵ All specimens recorded here are from California

- (1) Holotype ♀ : Clearlake Highlands, Lake County; on a porch screen. 31 October 1934; at noon (W. M. Hooton) [Calif. Acad. Sci., No. 4675].
- (2) Paratype ♀ : Sequoia National Forest, Tulare County. 1928 [E. Walter, Anaheim, California].

In a subsequent paper (1940, loc. cit. 35:46-50) Johnson described the male from a single specimen:

- (3) Plesio-allotype ♂ : ex. larva collected Lake County (exact locality unknown but probably near Clear Lake where the collector lived); on *Ceanothus cuneatus*. 23 or 28 May 1938, adult emerged 21 October 1938 (C. Macheboeuf) [Calif. Acad. Sci., No. 4908].

The account of the finding of the larva of this male has been related to us by J. W. Johnson (personal communication to Hogue — letter of September 7, 1959) who corresponded with W. M. Hooton, friend of the collector and his companion at the time of the collection. Johnson quotes from Hooton's comments in a letter dated May 26, 1938: "I was looking to the right and he (Charles M.) left, when he saw a larva on a small bush of Buckbrush, nearly mature, very similar to mendocino as regards green background, and tubercles, but these were wine or purplish color with white bars (8) between lowest two of three rows of spots. A second larva turned up later nearby. Five spines in spots as mendo- Bet is is *atlbefasciata*."

Johnson adds: "In a later letter dated June 12, 1938, he (Hooton) says that Charles M. took three larvae. In November-November 15, 1939, he writes that Charles M. took still another larva." Presumably the larvae other than the one which produced the plesio-allotype were lost.

Early Records

Macheboeuf's larvae were not actually the first discovered. The earliest collection of immatures was in 1934 by Johnson himself:

- (4) 1 larva: Stony Camp, Deep Creek Road (Rock Camp, north of Lake Arrowhead), San Bernardino Mountains, San Bernardino County; on buckbrush or similar *Ceanothus*, 12 May 1934 (J. W. Johnson) [specimen lost].

Concerning this collection, Johnson relates (personal communication to Hogue — letter of September 7, 1959), "This spun cocoon exactly like that of *albofasciata*, and produced a small male adult. It hatched while I was away from home and only the battered remains were found months later in the rearing box,...."

W. Bauer and J. S. Buckett add the following records from their collection:

- (5) 1 ♂, 1 ♀ : Clear Lake, Lake County. 24 October 1950 (C. Macheboeuf)
- (6) 1 ♀ : Konocti Bay, Lake County. 24 October 1957 (C. Macheboeuf)

- (7) 2 pupae: Clear Lake, Lake County; ex. *Ceanothus cuneatus*. No date.
(8) 5 eggs: Konocti Bay, Lake County; no host given. 24 October 1957

The only other record prior to 1951 is as follows:

- (9) 1 ♀: Jackson Lake, Big Pines Recreation Park, Los Angeles County; collected at light. 27 October 1950 (John Adams) [Los Angeles County Museum].

Recent Records

The following are the most recent collections and those which have contributed the necessary material for the elucidation of the life history:

- (10) 1 larva (penultimate instar): Kelseyville, 10 mi. W. on road to Hopland, Lake County; beaten from shrub, either *Ceanothus* or *Arctostaphylos*. 20 May 1959 (R. X. Schick) [Los Angeles County Museum].

The specimen was given to one of us (Hogue) by Schick for rearing a few days after it was collected. It molted successfully but died shortly afterwards.

- (11) 1 ♀: 0.2 mi. N. Rock Camp, North of Lake Arrowhead, San Bernardino County; at UV light, temperature 60-70° F., very dry, clear moonless night. 24 October 1959; 7:00 p.m., 1 hour after sunset (F. P. Sala & C. L. Hogue) [Sala].

This female was confined and laid 8 eggs. These and other biological data obtained from rearing this material and that listed in the records to follow are incorporated into the discussions of biology for each stage in a later section.

- (12) 1 larva (early instar): Newcomb's Ranch, San Gabriel Mountains, Los Angeles County; beaten from *Ceanothus* sp. (F. P. Sala) [specimen lost].

- (13) 1 larva (second instar): same locale as above: beaten from *Ceanothus* sp. 5 June 1960. (F. P. Sala) [Sala].

This specimen was successfully reared through to an adult female (emerged 21 October 1960).

- (14) 1 ♀: Same locale as above; at UV light. 21 October 1962; approximately 7:00 p.m. (F. P. Sala) [Sala].

- (15) 1 ♀: Charleton Flat, San Gabriel Mountains, Los Angeles County; resting on flat stone near registration building where some lights were on, specimen lethargic, apparently had been at rest for some time. 22 October 1962; 8:00 p.m. (J. Lane) [Sala].

- (16) 7 ♀♀: Willow Creek, near Lake Arrowhead, San Bernardino Mountains, San Bernardino County. 25 October - 5 November 1963. (E. Walter et al.) [Walter].

A large number of eggs were obtained from the 9 preceeding females and reared by Sala (#15) and Walter (#16).

- (17) 1 ♀: near Placerville, El Dorado County, elev. 2000 feet; at UV light. 25 October 1963; 8:00 p.m., 1 hour after sunset (R. Leuschner) [Leuschner].

The specimen was confined but failed to lay any eggs.

- (18) 1 larva (mature): vicinity Wrightwood, San Gabriel Mountains, San Bernardino County; ex. *Ceanothus cordulatus*, June 1963. ♂ emerged October 1963 (W. D. Dyer) [specimens and photographs in Los Angeles County Museum].

By far the largest number of adult specimens have been collected and observed by N. McFarland and C. Henne as follows (some are sight records only):

- (19) 25 ♂♂, 15 ♀♀: White Cliff Ranch, 2.5 mi. SSW. Valyermo, Los Angeles County; elev. 4800 feet. 22 October - 9 November 1963. [McFarland and Henne].
- (20) There are also several records by McFarland and Henne of larvae beaten from *Cercocarpus betuloides* and two particularly interesting observations of males copulating (in the late afternoon) with freshly emerged females sitting on the latter's cocoons which were spun on the same plant.

GEOGRAPHICAL DISTRIBUTION AND HABITAT

All the records of *S. albofasciata* are from mountainous regions, generally through the median elevations (approximately 4500 - 7000 feet) in the Transverse Ranges of southern California, and at lower elevations (down to 1300 feet at Clear Lake) in the northern Coast Ranges and Sierra Nevadas. When known fully, the distributional pattern will probably be found to correspond to that of the host plants. These are species which generally have small, thick leaves and belong to the chaparral or related xerophytic plant communities. Hot, dry summers and freezing (often snow covered) winter periods characterize the climates of these communities at the higher elevations where the moth is found.

The eggs of the moth apparently require freezing to break the winter diapause, an additional factor which no doubt limits the distribution to areas where this requirement is satisfied. In this regard it may be noted that in the southern Transverse Ranges, the moth is known only from the northern, protected and colder, slopes.

DESCRIPTIONS AND BIONOMICS

EGGS (Fig. 1)

Description. Size 1.9 x 1.5 mm.; large for the size of the adult. General proportions, markings and color as figured.

Bionomics. The number of eggs laid per female is not large. The average obtained from a sample of 13 females was only 17.2 with maxima and minima of 36 and 3, respectively.

Confined females lay primarily in the early evening hours between dusk and 9:00 p.m. Oviposition is nearly completed the first evening; a few eggs may be laid a second or third evening.

The eggs are firmly glued to the substratum singly or side by side in short strings of 2 - 10. The natural substratum is not known but probably is the twig bark of the host plants.

Eggs are laid during the fall flight of the adults and remain dormant until the following spring. A pronounced winter ovarian diapause is evident and freezing temperatures are apparently required for a time in order for this stage to develop normally.

MATURE LARVA (Figs. 5-6)

Description. (Only the most characteristic features of the mature larva will be described here; detailed anatomical analysis of all the instars is reserved for future work). Size small for genus, generally only two-thirds the length of *walterorum* or *mendocino*, i.e. 30-45 mm.

Structure, markings and color as figured, the prominent elements as follows: general ground color green; scoli bright pinkish or lavender; bright creamy yellow vertical bars connecting dorso-lateral and lateral scoli on abdominal segments, touching caudal edge of spiracles; conspicuous lanceolate, flat, papery, silvery spines projecting from scoli and integument usually as follows: a single large one from each dorso-lateral scoli on abdominal segments 2-7 and one or two smaller ones from near the bases of the dorsal scoli of segments 1-8; the other scoli spines normal, small, black and bristle-like, some in the form of very long slender hairs.

There is considerable variation in the individual shape, size and distribution of the flat lanceolate spines. Some larvae are completely without them, their places being taken by unmodified, elongate setae. They are always absent from the younger instars.

Bionomics. The larvae hatch in the usual saturniine manner and pass through four instars. Development proceeds uninterrupted by dormant periods of diapause.

The larvae feed externally on the leaves of the host plant. The species of the latter are not known with surety. Larvae have been taken from *Cercocarpus betuloides* Nuttall—Mountain Mahogany (#20) and two species of *Ceanothus* in nature: *C. cordulatus* Kellogg—Snow Bush (Dyer, #18) and *C. cuneatus* (Hooker)—Buck Brush (Macheboeuf and Johnson, #3). *C. Greggii* Gray may be a host in the White Cliff Ranch area where much adult activity was recorded in 1963 and 1964. In the laboratory the larvae feed readily on other species of *Ceanothus* (e.g. *leucodermis* Greene and *spinosus* Nuttall), and *Fremontia californica* Torrey, also a chaparral species.

These facts imply that a wide range of chaparral plants may serve as hosts. This tendency is evident in other *Saturnia* species, including the close relatives of *albofasciata* (Sala and Hogue,

1958:24). These moths seem to exemplify cases of larval adaptation to a plant community rather than to a single plant species or taxonomic group as is most often the case.

The larvae are not especially active, and crawl slowly. They are extremely delicate in captivity. Rearing conditions must be closely controlled: food must be very fresh; the larvae must have 2 or more hours of sunlight and semi-shade, and moving air, every day. McFarland found it advantageous to cover the rearing cages with plastic bags indoors to prevent dehydration when the food plant begins to wilt. In spite of such careful handling, McFarland succeeded one season in obtaining only 14 pupae from 108 eggs. It is evident that the larvae have certain requirements that are not yet understood.

PUPA AND COCOON (Fig. 2)

Descriptions. Pupa small for genus, length approximately 13 mm. Cremaster with single spine.

Cocoon very different from *walterorum* or *mendocino*: size small, length 20-25 mm.; color variable: pale sulfur yellow to yellowish-orange, usually "salmon-orange," occasionally dull brown; wall tough, texture smooth or slightly wrinkled with closely spun single wall (without the loose, outer fenestrate weir of *walterorum*, *mendocino*, and *Agapema*); emergence exit pre-existent, of the "draw-string" type.

Bionomics. The cocoons are formed in the early summer (late June-early July). The species remains in this stage until late October, the time of emergence and adult activity. Thus there is regularly a second period of diapause-like dormancy in the life cycle of this species.

ADULTS (Figs. 3-4)

Descriptions. The adults are adequately described and figured by Johnson in his original papers (1938; 1940) and his black and white photographs in the latter paper readily permit recognition of both sexes of this unique *Saturnia*. Our figures 3 and 4 are provided so that the colors may be appreciated.

The wing patterns bear an interesting relationship to the other American members of the genus. With regards to the upper surfaces only, the *male* pattern and color closely mimic that of *S. (Calosaturnia) walterorum* and *mendocino*. The major exception is the white bar midway along the inner area projecting towards the ocellus. This bar is also present in the female, but, unlike the male, reaches the ocellus and has a mate in the hind wing. It apparently represents the proximally displaced, caudal sector of the TP line. The ground color of the hind wings

of the male also are much redder than the pure orange of the other species. The overall pattern and colors of the *female* pattern are like those of the subgenus *Agapema*, especially *A. galbina*.

From these characters, *albofasciata* can be thought to occupy an intermediate morphological position between the other two species of *Calosaturnia* and species in the genus *Agapema*. This intermediacy is demonstrated as well by other structural and behavioral characteristics (See Table 1).

These facts make possible some interesting speculation regarding the phylogenetic history of the American *Saturnia* from which may be derived a better interpretation of the taxonomic status of *albofasciata* than presently stands. These will be considered in the following section.

The male genitalia of *albofasciata* are like those of other *Calosaturnia* in lacking a sclerotized aedeagus.

Bionomics. The adults are active in the fall of the year, primarily in late October and early November. The females are crepuscular and nocturnal (early evening); the males fly during mid- and late afternoon. As indicated by confined specimens, and those taken at light, the females fly into the early evening during which time they oviposit. They settle down by late evening and are inactive through the rest of the night and following day. The males actively seek out "calling" females in the late afternoon and copulation takes place where the latter are found. Copulation probably stimulates the female to flight and oviposition.

The flight characteristics of the male are similar to those described for *S. (Calosaturnia) walterorum* (Sala and Hogue, 1958:18). The moths fly very rapidly, 3-10 feet above the ground, dodging and bobbing erratically. This, plus the usually rough terrain of their habitat, make them difficult to net. They are particularly quick to react to the sound of a snapping twig, or a bush brushed by the collector.

Collecting is productive for females with lights set out just at dusk. They are attracted to both Coleman lantern and black light.

CHRONOLOGY OF THE LIFE CYCLE

One brood per year

Mid-fall (late October): adults emerging and active. Eggs laid.

Late fall-winter (November-April): eggs dormant. (ovarian diapause).

S. (Calosaturia) mendocino and walterorum		S. (Calosaturia) albofasciata		S. (Agapema) galbina and homogena	
♂	♀	♂	♀	♂	♀
1. diurnal	1. diurnal	1. diurnal	1. nocturnal	1. nocturnal	1. nocturnal
2. eyes small	2. eyes small	2. eyes small	2. eyes large	2. eyes large	2. eyes large
3. antennae bipectinate	3. antennae bipectinate	3. distal rami partially developed	3. antennae quadri- pectinate	3. antennae quadri- pectinate	3. antennae quadri- pectinate
4. brightly colored	4. brightly colored	4. brightly colored	4. dull colored	4. dull colored	4. dull colored

Table 1: Comparative anatomy and behavior of S. (Calosaturia) and S. (Agapema)

Early spring (April-May): eggs hatch.

Late spring-early summer (April-June): period of larval development.

Early summer (late June-early July): spinning and pupation.

Summer-mid-fall (July-late October): pupal period. (pupal diapause).

There are some questions raised by this unique life cycle pattern: Firstly, how does it relate phylogenetically to the patterns of the species' close relatives, especially the dual dormancy (diapause?) phase? In this regard, it is interesting to note that the pupal state of *albofasciata* has the pre-emergence development phase much the same as *walterorum*, and no doubt *mendocino*.

Secondly, what is the relationship of the ovarian period of dormancy to the pupal dormancy in this moth—and for that matter in other Lepidoptera and insects? Demonstrated again is the need for a better definition of the terms diapause and dormancy.

PHYLOGENETIC CONSIDERATIONS AND TAXONOMY

The genus *Saturnia* (sensu Michener 1952:477) is represented in America by only five species grouped into two subgenera: (*Calosaturnia*) *albofasciata* (Johnson), *mendocino* (Behrens), *walterorum* Hogue and Johnson (*meridionalis* of Johnson); (*Agapema*) *galbina* (Clemens) (including three subspecies) and *homogena* Dyar. The genus is well developed, by contrast, in the Old World. It seems certain that the ancestor of our species migrated here from Asia relatively late in saturniine evolution (Michener 1952:371). The subsequent pattern of divergence taken by descendents of the ancestor which produced our present species is, of course, unknown but can be inferred from their comparative anatomy and behavior. Assisted by the foregoing new information on *albofasciata*, we are able to suggest the following as the most likely hypothesis:

The Old World subgenus *Eudia* is closest to *Calosaturnia* and *Agapema* structurally. A single ancestral form probably resembling types like *Saturnia* (*Eudia*) *pavonia* or *spini* migrated into the mountainous Pacific region of North America by way of a past Bering land connection. The amazingly close parallelisms in wing color and bionomics which exist between *pavonia* and *albofasciata* strongly suggest very close relationship, possibly even a common ancestor quite like both of them, but probably tending more toward *pavonia* which exhibits the more primitive

anatomy (e.g. "noctuiform" wing pattern, sclerotized aedeagus, larger size, etc.).

This ancestral form probably was adapted to cool, dry mountain climates and the larvae fed on shrubs as do *pavonia*, *walterorum* and *mendocino* presently. We would speculate also that the males were diurnal and the females nocturnal. Derived from this ancestor are our current two distinct lines *Calosaturnia mendocino* and *walterorum*, on the one hand, in which both sexes are diurnal and brightly colored and *Agapema*, on the other hand, in which both sexes are nocturnal and dull colored.

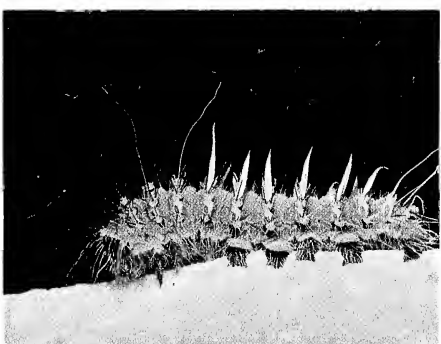
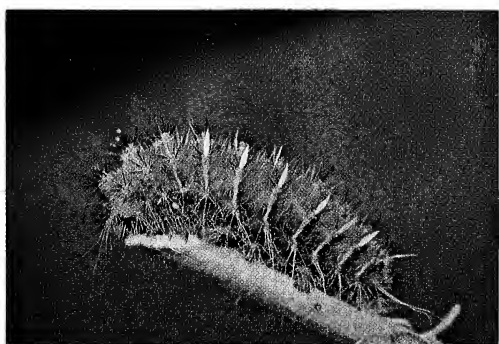
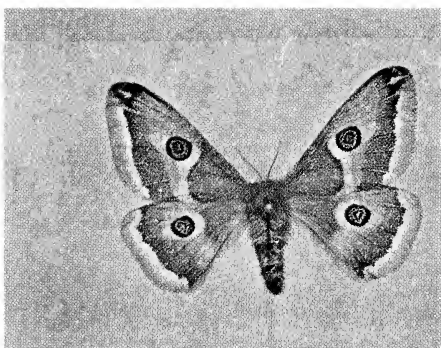
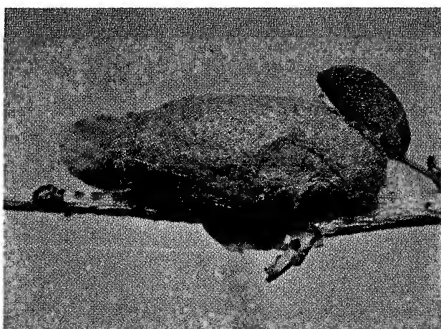
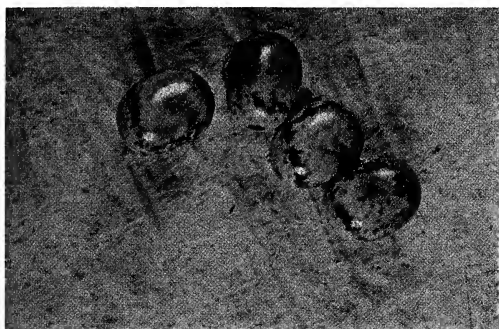
It is, to say the least, highly precarious to attempt an explanation of the origin of this dichotomy without some investigation of the genetics of the species concerned. Yet we would like to cautiously suggest that the two lines arose directly out of the sexual dimorphism of the adults. Besides *pavonia* and *albofasciata* there are other examples among bombycoid moths in which the males (usually with rust or reddish wings) are diurnal and more brightly colored than the females which are nocturnal and dull colored (usually light grey or brown): *Endromis versicolora* (Endromididae; Palaearctic), *Aglia tau* (Saturniidae; Palaearctic), *Polythysana andromeda* (Saturniidae; Chile).

The males and females of such species are actually considerably divergent morphologically and behaviorally. It is conceivable that individuals of both sexes would appear with characteristics more similar to the opposite sex. Some of these characteristics might affect mating frequency so that like individuals would tend to cross more readily than unlike, e.g., mutant night-flying males might encounter more females also in flight than normal males would resting, motionless females, or brightly colored females might appear which would be more easily encountered by males during the day than the dull colored normals.

Other factors would tend to complicate these simple examples, such as pheromone effectiveness, predator attention, visual acuity, etc., but we think it not too far wrong to postulate divergent populations, (species and even genera) developing from such anomalies, with their total members more similar than the normal sexes of *albofasciata* are different.

ACKNOWLEDGMENTS

We wish to thank John Johnson, Corona del Mar, for contributing the information necessary to reconstruct the early records and knowledge of the species. The following persons



Figures 1-6: *Saturnia albofasciata* Johnson.

1: Eggs. 2: Cocoon. 3: Adult male (live specimen). 4: Adult female. 5: Mature larva. 6: Newly molted final instar larva, showing dorso-lateral lanceolate spines particularly well.

generously made available records from their own collections: William Bauer, Petaluma; Steve Buckett, Petaluma; W. David Dyer, Los Angeles; John Lane, Los Angeles; Ronald Leuschner, Gardena; Erich Walter, Anaheim. We also acknowledge the assistance of Leonila Vázquez G., Mexico City, for checking the type material of *Saturnia albofasciata* for us during her visit to the California Academy of Sciences in 1962.

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THE NOCTUID MOTH *ANNAPHILA BAUERI*

WITH NOTES ON ITS HABITS

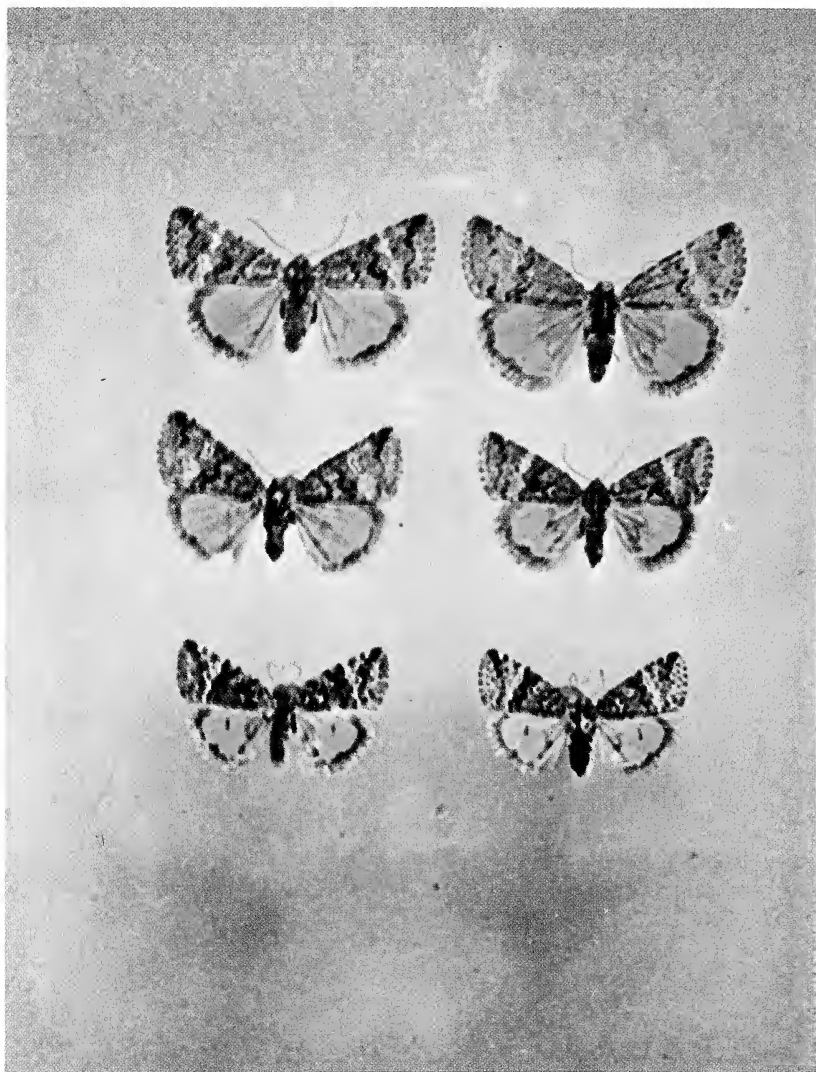
JOHN S. BUCKETT

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SINCE THE DISCOVERY of *Annaphila baueri* Rindge & Smith in the late 1940's, and since the original description, many additional specimens have been collected. The type locality is Anderson Springs, four miles northwest of Middletown, Lake County, California, and until recently the species was known only from this immediate vicinity. In the early 1960's the author, and Mr. Bauer (for whom the species is named) discovered other collecting areas for *baueri*, one of which is to the north of the type locality near Kelsey Creek, Lake County, another area being on Mt. Sanhedrin, Mendocino County. Mr. C. Henne also discovered specimens in San Bernardino County which answer to the description of *baueri*, thus extending the range of the species far to the south. Thus far, it has only been collected in, and is probably restricted to, California.

The species was described from specimens collected at an altitude of 1400 feet above sea level. The Kelsey Creek specimens were collected at an altitude of over 2500 feet, the Mt. Sanhedrin specimens at an altitude of over 3000 feet, and the southern specimens were collected at an altitude of 5000 feet. The species flies during February, March, and April, with early to mid March being the peak of flight period for the northern populations.

A. baueri is a strong, erratic flier, and is quite difficult to secure while on the wing; it is more easily collected while at rest or when feeding. The author has taken specimens of *baueri* while they were feeding on Baby Blue-eyes (*Nemophila menziesii*), Parry's Manzanita (*Arctostaphylos manzanita*), White Alder (*Alnus rhombifolia*), and the Arroyo Willow (*Salix lasiolepis*). Many specimens were collected from dead limbs or branches, where the moths were apparently resting or sunning themselves. One can also collect speci-



- Fig. 1. Paratype female, *Annaphila baueri* Rindge & Smith, Anderson Springs, Lake County, California, 26 March 1949 (W. R. Bauer).
- Fig. 2. Male, *A. baueri*. Kelsey Creek, 3 miles west of Cobb, Lake County, California, 13 March 1961 (J. S. Buckett).
- Fig. 3. Male, *A. baueri*, same locality as figure 2, 17 March 1960 (W. R. B. & J. S. B.).
- Fig. 4. Male, *A. baueri*, same locality as figure 2, 7 March 1959 (W. R. B. & J. S. B.).
- Fig. 5. Male, *A. abdita* Rindge & Smith, same data as figure 3.
- Fig. 6. Female, *A. abdita*, same locality and collectors as in figure 3, 18 March 1960.

many other *Annaphila*, frequently use streams for flyways.
many other *Annaphila*, frequently use streams for flywals.

The optimal temperature for flight of *baueri* has not been ascertained, but the minimal temperature for flight seems to be very near 65°F. It will not fly if the wind is at all strong, nor will it fly if the sun is not showing to some degree. Hazy days can be very good collecting, providing the temperature is adequate. If the temperature reaches the high seventies, or the low eighties, it is almost impossible to collect many specimens due to their ultrakeen alertness accompanied with the fact they are very "warmed up". The slightest quick movement, or the first snapping of a twig or dead leaf will send the specimen into a very erratic flight which may be within ten feet of the ground, or may be at much higher altitudes, thus making it almost impossible to catch.

One can take an occasional specimen of *baueri* before noon, but generally the majority of the specimens are collected between 1 PM and 3 PM when they are most concentrated on feeding. On the fifteenth of March, 1960, Mr. Bauer and the author collected specimens of *baueri* at regular intravels until 5 PM, and one specimen was collected at 5:45 PM! These specimens were apparently coming into a secluded wooded area for the night where they alighted on dead limbs in a burned over area. Two years later this area was again burned over, this time rendering the terrain useless for *Annaphila* collecting.

Rindge & Smith (1952) give a very adequate description of *baueri*, and the only supplemental data the author presents here is greater variation in size and in color, range extensions, and a plate showing color variation. (Figs. 1-4). For notes on the immature stages of *baueri*, see Comstock and Henne (1964).

The male genitalia is presented here with the aedeagus illustrated, being inflated to more clearly show the form and armature of the vesica. (Figs. 7, 8). *A. baueri* is quite a distinct species, its closest relative being *abditata* Rindge & Smith, which is much smaller. The maculation of the two species is similar, yet each is distinctly different, as can be seen by the colored plate of the adults. (Figs. 5, 6). Also Rindge & Smith (op. cit.) state in reference to *baueri* "In this species the front is strongly raised, with the apex truncate, while in *abditata* the front has a strong transverse ridge across the top and bottom." This characteristic holds well for each species.

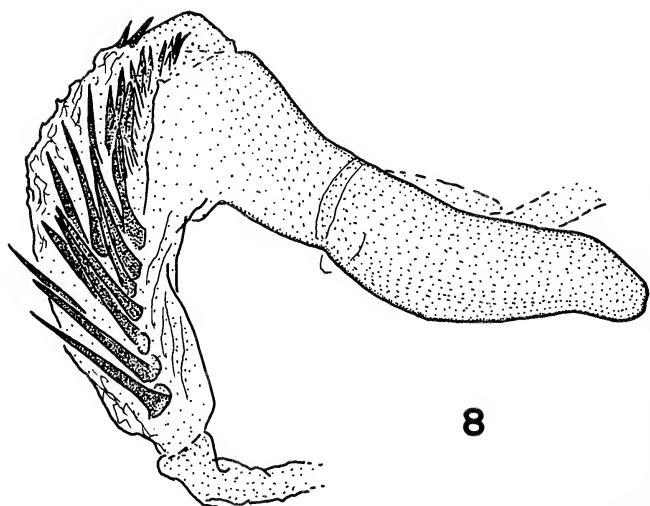
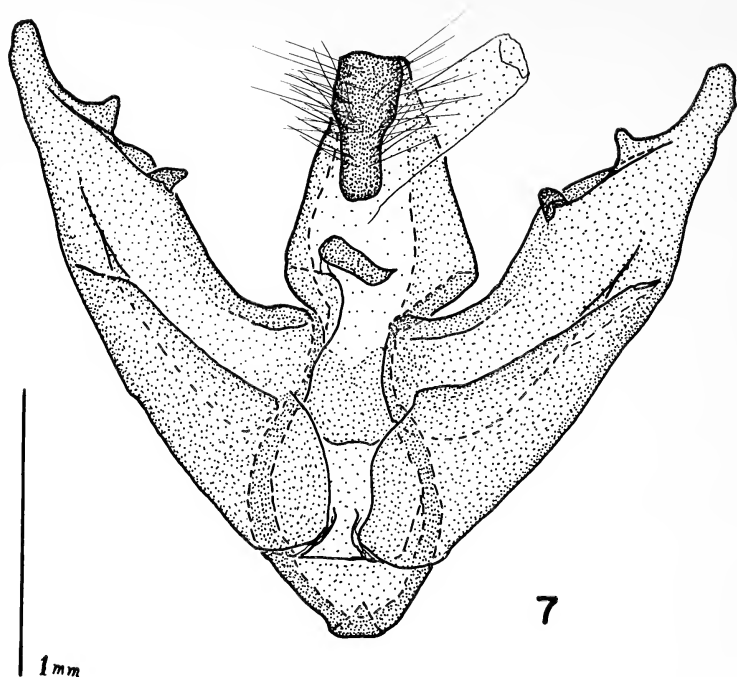


Fig. 7. Topotype male, *A. baueri*, genitalia minus aedeagus. Same locality as in figure 1, 20 February 1955 (W. R. B. & J. S. B.), Bauer-Buckett slide number 63B20-43.

Fig. 8. *A. baueri*, inflated aedeagus. Same data as in figure 7.

The specimens examined are as follows:

CALIFORNIA, Anderson Springs, Lake County, 2 paratype females, 26 March 1949 (W. R. Bauer); 1 female, 12 February 1955 (W. R. B. & J. S. Buckett); 1 male, 1 female, 20 February 1955 (W. R. B. & J. S. B.); Kelsey Creek, 3 miles west of Cobb, Lake County, 2 males, 2 females, 1 March 1959 (W. R. B. & J. S. B.); 1 male, 3 females, 8 March 1959 (W. R. B. & J. S. B.); 2 females, 14 March 1960 (W. R. B. & J. S. B.); 4 males, 2 females, 15 March 1960 (W. R. B. & J. S. B.); 2 females, 16 March 1960 (W. R. B. & J. S. B.); 1 female, 17 March 1960 (W. R. B. & J. S. B.); 6 males, 1 female, 13 March 1962 (J. S. B.); 1 male, 1 female, 17 March 1962 (J. S. B.); 3 males, 2 females, 20 February 1965 (W. R. B., J. S. B. & M. R. Gardner); 2 males, 6 females, 21 February 1965 (W. R. B., J. S. B. & M. R. G.); Mt. Sanhedrin, Mendocino County, 1 female, 23 March 1960 (W. R. B. & J. S. B.); Cedar Pines Park, near Crestline, San Bernardino Mountains, San Bernardino County, 1 male, 13 April 1960, 5000 feet elevation (C. Henne), with affixed label reading "Alighting on dried vegetation, Mid-afternoon".

The specimens used in this work are in the Bauer-Buckett Collection, Davis, and the Entomology Collection, University of California, Davis, California.

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- COMSTOCK, J. A. and C. HENNE, 1964. Studies in Life Histories of North American Lepidoptera. *Jour. Res. Lep.* 3(3): 173-191.

NOTICES

THE EDITOR requests that readers send in good black and white glossy prints of any subject related to *Lepidoptera*. These must include a brief description or legend. The purpose of these is the great need by the editor for some short fills between the longer papers, and to bring about a more diversified interest in each issue. Short notes can be sent to satisfy the same need.

A NOTE to authors sending in color for reproduction: Send sharp, brilliant transparencies, preferably 35mm. A long delay may ensue for color. Reproduction from color prints or from drawings are much more expensive and authors are to be expected to pay the extra cost.

S. O. S. The editor has nearly caught up with the publication schedule of the Journal after the delays of the past year. Because of these delays, many authors have not sent their manuscripts in to the editor and we are now nearly exhausted. Manuscripts can now be received for rapid publication.

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CALIFORNIA COASTAL EUPITHECIAS

WITH DESCRIPTION OF A NEW SPECIES (*Geometridae*)

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THE COAST OF CALIFORNIA has always been an excellent collecting location due to its unique ecology. Yet after early work in the San Francisco area by Behrens and Henry Edwards, very little collecting has been done there, considering the potential rewards that are available. As a case in point, consider *Lithophane vanduzeei*. This fine Noctuid has been taken rarely, if at all, since its original description from the coastal region. Yet it was recently re-discovered in the Carmel-Monterey area, on three separate occasions, by collectors who finally ventured into this area at the proper time.

The coastal region as defined in this paper extends, in a somewhat disjoint manner, from San Diego to Inverness in Marin County. Thus included are the fine stands of pine and cypress at Inverness, Carmel, Cambria, and Oceanside. The forests of Mendocino County northward have been intentionally excluded; the insects here are, in general, quite different. Some of the species of the southern-more coast are indeed found all the way to Vancouver; yet looking in the other direction, there are many species whose southern terminus is in Mendocino County.

It would be desirable to publish a list of all Lepidoptera of the California Coast. However, this paper has been necessarily restricted to a more modest undertaking — a discussion of the Geometrid moths of the genus *Eupithecia*, from the coastal region. This particular genus reaches an amazing development here. Of the 66 species found in California, at least 27 have been found along the lower coast. Further, it was possible to capture 14 of these species in a single night of collecting at one location (with black light in the beautiful forest overlooking Monterey Bay).

Table 1: Occurrence of California Coastal Eupithecia's throughout the Year

Name	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1. Karenae				3-Cmb 7-Crm		8-Cmb	2-Inv	4-Inv	1-Cmb	1-Crm	1-Inv	6-Crm
2. Columbiata				3-Crm		1-Cmb	3-PV		1-Cmb			
3. Meestosa				1-Inv		2-Cmb			2-PV		1-Inv	8-Crm
4. Sabulosata				5-Crm		16-Cmb						
				1-Cmb								
5. Subvirens				1-Cmb		11-Cmb	8-Cmb		2-Cmb			2-Inv 4-Crm
				3-Crm	1-SB					1-PV		
6. Placidata						1-SB	1-PV					
7. Macrocarpata							3-Brk					
8. Misturata							3-Cmb		1-PV			3-Crm
9. Miserulata zela					1-PV		2-PV			1-PV		
10. Bivittata		1-Inv		3-Cmb 1-Crm		5-Cmb 1-Inv	4-Cmb 2-Inv					
				1-Inv								
11. Albipunctata					5-Inv							
12. Rotundopuncta				26-Crm 15-Cmb 4-Inv	15-Inv	1-Cmb						
13. Iitoris									1-PV			
14. Macdunnoughi				3-Inv								
15. Cupressata						1-Crm		1-Crm				
16. Cognizata				1-Crm								
17. Annulata				2-Crm								
18. Niphadophilata(?)				4-Inv								
19. Furpurissata												
20. Subapicata						15-Crm						
				9-Inv								
21. Shirleyata				1-MB								
				1-Cmb								
22. Graefii				1-Cmb	1-Inv	1-Cmb				2-Crm		1-Crm
				7-Crm								
				1-Inv								
23. Nevadata				1-MB								
24. Implorata				8-Crm								
25. Cestata				1-Inv								
26. Cestatoides												
27. Ravocostaliata				2-Crm								

Code:

Brk = Berkeley, Alameda Co.
 Cmb = Cambria Pines, San Luis Obispo Co.
 Crm = Carmel, Monterey Co.
 Inv = Inverness, Marin Co.
 MB = Morro Bay, San Luis Obispo Co.
 PV = Palos Verdes, Los Angeles Co.
 SB = Santa Barbara, Santa Barbara Co.

No specific records

X

Table One presents the occurrence of these species over all months of the year, from the author's experience. Note that many of these species can be taken essentially at any time of the year — *subvirens*, *sabulosata*, *graefti*, and also the new species to be described here, *karenae*. The data here is just a beginning: a few more collecting trips in the early part of the year would certainly add numerous entries.

In Table Two, the distribution pattern of those Eupithecia's found along the coast is summarized. Some species range far indeed: *maestosa* and *placidata* are found in most of the western states, while *misturata* is found across the entire continent, including its eastern race. Yet at least nine of the species are found only (so far) along the coast. This latter group of localized species includes the rarer and most prized specimens such as *karenae*, *macrocarpata*, *cupressata*, and *purpurissata*.

These brief facts must serve to set the stage for the description of a new species of *Eupithecia* whose habitat is this coastal region. A search of the literature, (including McDunnough's comprehensive monograph) and museum collections (LACM, AMNH) has not disclosed an available name for this species, and only a couple specimens, yet in the past five years it has been taken in relative abundance.

Eupithecia karenae, n. sp.

Female: The ground color of the primaries is a rich golden or red brown. The lines are contrastingly black, shaded outwardly with white. The basal line is small, fine, evenly rounded outwardly. The AM starts at the costa at the one-third point, and in the upper half of the wing curves evenly around toward the inner margin. However, just below Cu, the AM projects sharply outward in a pointed, horizontal "tooth" which intersects the PM line. The remainder of the AM below this tooth is only faintly indicated, but is double if traceable. The PM is smoothly sinuate, being concave at the inner and outer margins and convex in the cell. It is followed by a parallel lighter band greater than its width, edged with gray. The appearance here, in many specimens, is that the PM is geminate. The ST is complete, accentuated with white near the apex and by a series of black blotches from the middle of the wing toward the inner margin. There is a sharp inward jog at the anal angle, where the black shading is most prominent (Fig. 1 A).

The secondaries are much lighter, but still well shaded with brown outwardly and along the anal margin. The PM is distinct,

Table 2: Distribution of California Coastal Eupithecia's

Name	Calif. Coast only	N.Calif. Coast, Oreg.; BC	Also found in:		Rocky Mts., Ariz.	Eastern and Canada
			Inland in Calif.	Sierra's		
1. Karenae	X					
2. Columbiata		X				X(race)
3. Maestosa		X	X	X	X	
4. Sabulosata	X					
5. Subvirens	X					
6. Placidata		X	X	X	X	
7. Macrocarpata	X					
8. Misturata		X	X	X	X	X(race)
9. Miserulata zela	X					X(race)
10. Bivittata	X					
11. Albipunctata		X				
12. Rotundopuncta		X				
13. Litoris		X				
14. Macdunnoughi			X	X	X	
15. Cupressata	X					
16. Cognizata	X					
17. Annulata		X			X	X
18. Niphadophilata		X				
19. Purpurissata	X					
20. Subapicata		X				
21. Shirleyata	X					
22. Graefii		X	X	X		
23. Nevadata		X	X	X(race)	X(race)	
24. Implorata		X				
25. Cestata			X			
26. Cestatoides			X			
27. Ravocostaliata		X				X

black, and straight. The ST is indicated by blackish shades edged outwardly with white.

The underside is whitish with a tan tinge. The most prominent marks are the PM line of both wings at the outer margin; it gradually fades out toward the inner margin. There are distinct discal marks on all wings which do not show above. The forewing has an elongate discal bar, while the hindwing has a minute dot.

Wing expanse is 19 - 22 mm.

Female genitalia: The ductus bursae enters at the apex of the extremely slender, highly striate bursa neck. The latter, in turn, is attached to the bursa just inside a striated, raised ring. The bursa is quite globular, with spining all around on the upper two-thirds. The ductus seminalis is a tube of even width, attached near the apex. The female genitalia, as a whole, appears much like an apple, complete with a long slender stem (Fig. 1 C). The appearance is closest to that of *E. subvirens*, but differs in that the latter has a much stouter neck.

Male: Identical with the female in pattern and coloration. Wing expanse is 18 - 19 mm. (one example taken in September is only 15 mm.).

Male Genitalia: The clasper is long and narrow, almost straight along the basal two-thirds of its outer edge, with a slight bulge on the inner edge (Fig. 1 B). The ventral plate of Segment VIII is highly chitinized, with excellent characters present. The general shape is that of a horse-shoe, formed from two narrow curved rods becoming hook-like in their apical third. Just before the apex there is a relatively large, rounded lobe projecting inward (somewhat like *E. palpata*), formed by a thin membrane on a stouter base (Fig. 1 D). The shape of this plate is closest to that of *E. maestosa*, yet the latter has no inward projecting lobes.

Holotype — ♀, Carmel, Monterey Co., Calif. April 4, 1960 (R. H. Leuschner) To be deposited in the Los Angeles County Museum collection.

Allotype — ♂, Carmel. Dec. 30-31, 1962 (R. H. Leuschner) In author's collection.

Paratypes — 3 ♂, 9 ♀, Carmel. April 4, 1960 (5); April 4, 1965; Oct. 22, 1963; Dec. 30-31, 1962 (5). (R. H. Leuschner)

5 ♂, 7 ♀, Cambria Pines, San Luis Obispo Co., Calif. April 4, 1964; April 3, 1965 (2);

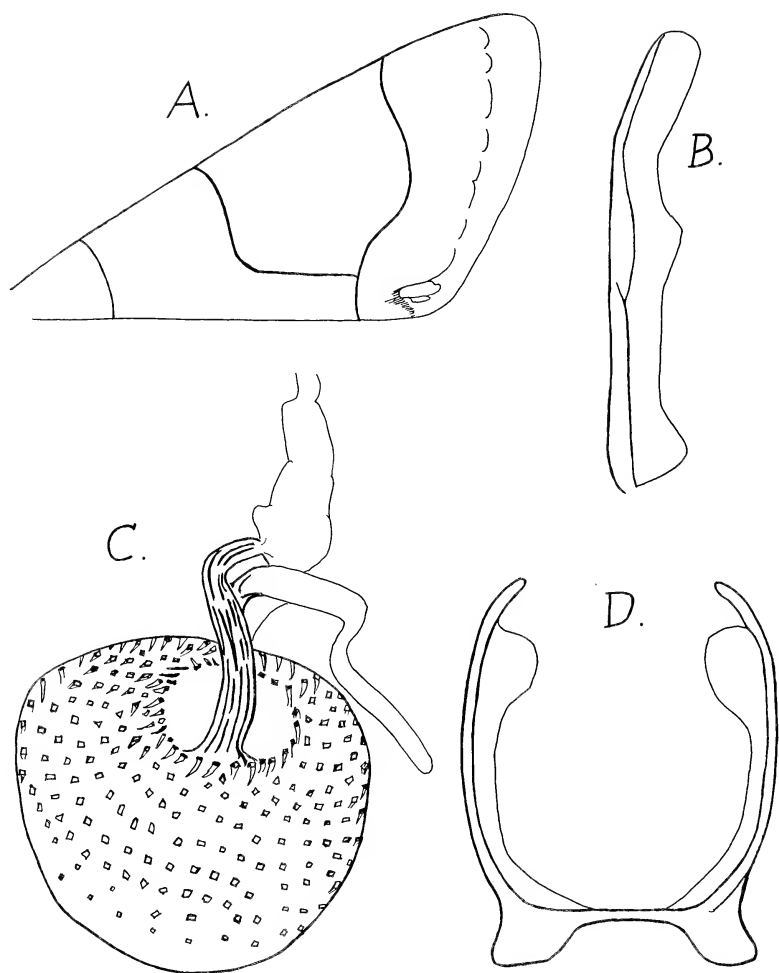


Fig. 1. *Eupithecia karenæ*, n. sp. A: forewing pattern; B: left clasper of male genitalia; C: female genitalia; D: ventral plate of male sternite VIII.

June 23, 1961 (8); Sept. 11, 1961. (R. H. Leuschner)

6 ♀, Inverness, Marin Co., Calif. July 27, 28, Aug. 5, 6, 19, 27, 1962 (C. W. Kirkwood)

1 ♀, McClure Beach, Pt. Reyes Peninsula, Marin Co., Calif. Nov. 19, 1957 (W. R. Bauer, S. Buckett)

Paratypes will be deposited in the following collections and museums: Leuschner, Kirkwood, Bauer-Buckett, AMNH, CNC, and USNM.

In addition to the above series, there is a singular female specimen of this species in the California Academy of Sciences collection, ex Guedet collection. The label data states: "Chiricahua Mts., Ariz. 9-9800 ft. July 28, 1927 J. A. Kusche, coll." This distribution is so disjoint with the known habitat of this species that it must be held a labelling error unless additional captures from Arizona can be made. Yet it should be noted that *E. macdunnoughi* does have just such a range, being found on the California coast and also through the mountains of Nevada down into Arizona.

REMARKS: This extremely well marked species can hardly be confused with any other. The general reddish or rich brown color is in sharp contrast to the majority of the *Eupithecia*'s, most of which are gray or blackish. Although the genitalia in both sexes show some similarity to those of *E. palpata*, the joining of the AM and PM lines is a character unique in the *palpata* (long palpi) group, and thus *karenae* should readily be identified. It seems amazing that so well-marked a species should have escaped description for all this time. It is a pleasure to name this species for my daughter, Karen, who accompanied us on the trip on which the first specimens were found.

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A REEVALUATION OF *Annaphila casta* (Noctuidae)

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THE ORIGINAL DESCRIPTION of *Annaphila casta* Henry Edwards was based on ten female specimens captured by Lord Walsingham in 1872. No males were included in the type series and none were known to exist in collections until recently.

In 1962 one male and three female specimens of *casta* were collected five miles northwest of Corvallis, Benton County, Oregon, thus now allowing further evaluation of the species and its relationship to other species within the genus. For many years it has been standing debate as to whether *casta* is most closely related to its superficially close counterpart *A. diva* Grote, which also possesses whitish secondaries, or whether it is most closely related to the *lithosina-miona* group as is evidenced by the female genitalia.

Dissection of the male specimen was made and the genital organs were mounted on a slide within balsam media. The genital organs were stained with lignin pink to better contrast the weakly sclerotized areas; the vesica of the aedeagus has been inflated to more clearly illustrate cornuti as well as to show the shape of the vesical sac. (Figs. 1, 2)

The specimens of *casta* were given, and in part loaned to the author by the collector, Mr. A. Noel McFarland of Valyermo, California. The genitalic illustration minus the aedeagus was graciously prepared by Mr. Jacques R. Helfer of Mendocino, California, and the aedeagus was illustrated by Miss Judith Jay. Thanks is also due to Dr. Frederick Rindge (American Museum of Natural History), Mr. Michael Gardner, and Mr. William Bauer for their assistance on this project.

***Annaphila casta* Henry Edwards**

Annaphila casta Henry Edwards, 1890. Ent. Amer. 6:114. J. B. Smith, 1893. Bull. U. S. Natl. Mus. 44:296. Dyar, 1902. Bull. U.S. Natl. Mus. 52:208. Hampson, 1910. Cat. Lep. Phal. Brit. Mus. 9:482, pl. 147, fig. 12. Strand, 1912. Lepidopterorum Catalogus, part 5, page 59. Draudt, 1927. In Seitz, Macrolepidoptera of the World, 7:329, pl. 47f. Rindge and Smith, 1952. Bull. Am. Mus. Nat. Hist. 98(3):228.

Male: Head with front strongly projecting with conical prominence, this prominence clothed in black and white scales, also scantily clothed in red-brown hairs; palpi clothed in black and white hair-like scales; antennae black, with scape and pedicel clothed ventrally in pure white scales, dorsally clothed with banded black and white scales for basal one third, remainder

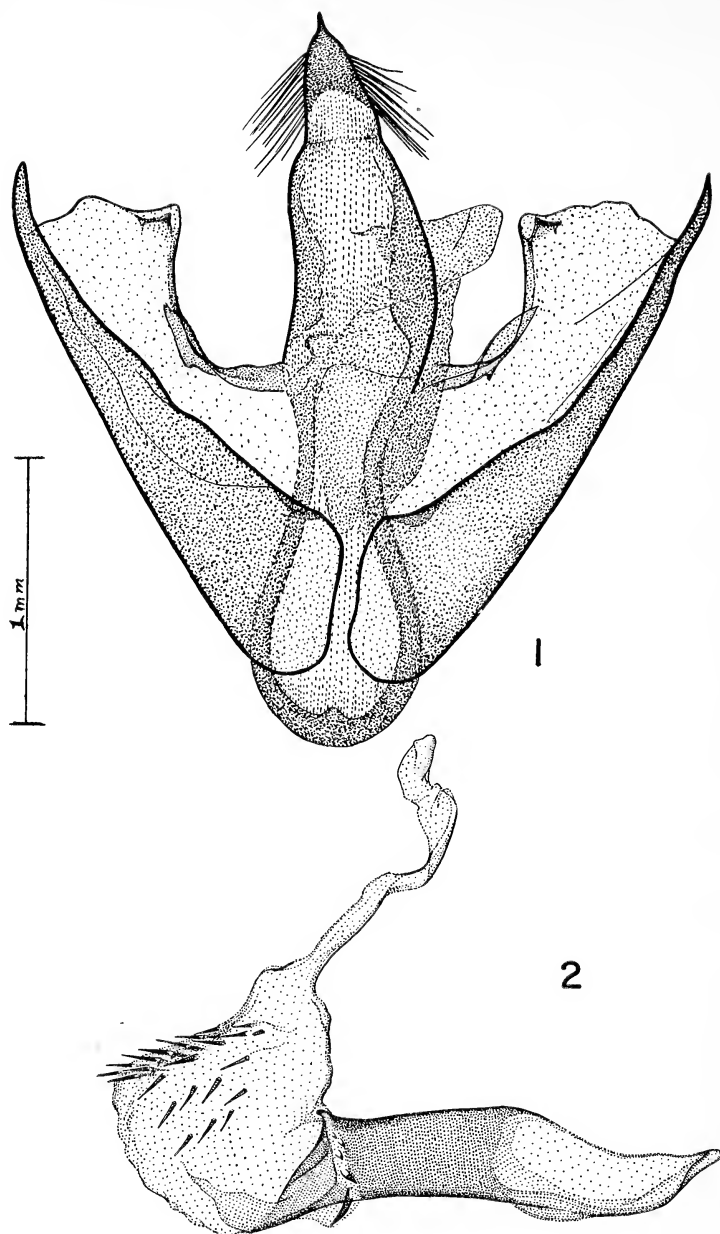


Fig. 1. *Annaphila casta* Henry Edwards, male genitalia minus aedeagus. 5 miles northwest Corvallis, Benton County, Oregon, 16 May 1963 (A. N. McFarland).

Fig. 2. *A. casta*, inflated aedeagus of male genitalia. Data same as in figure 1.

black scaled; thorax with collar of white-tipped black spatulate scales intermixed with longer red-brown hairs; disc with small coal black scales; tegulae clothed in white, black, and various shades of brown spatulate scales, these scales being evenly rounded apically, not dentate; ventrally clothed in pure white hairs; legs with tarsi black and white banded. Primaries with basal line geminate, black, included space olivaceous; basal and transverse anterior areas olivaceous; basal area also with intermingled red-brown hairs; transverse anterior area becoming lighter near transverse anterior line; transverse anterior line black, oblique, reaching furthest apically on medial veins, then irregular to inner margin, scales in areas proceeding transverse anterior line spatulate and not dentate apically; median area smokey black; orbicular hardly discernable, a thin black filled gray circle; broad white band cuts laterally across forewing from costa to inner margin and from basad of reniform to transverse posterior line, the basal line of white band indented medially; reniform appears as thin gray lunule, this lunule being the distad line of reniform proper; distad of reniform appear two circles of dark gray brown scales outlined in white, the lower one being the largest; below these circles wing washed with gray to inner margin; transverse posterior line gray-brown, prominent from costa to middle of wing then indistinct; subterminal area black, disappearing below large circle; subterminal line represented costally by white wedge, then appearing as dividing line between subterminal area and bluish terminal area; terminal line represented by a series of black dots surrounded by blue; fringes smokey black; ventral surface with ground color pure white; lateral black band from costa to inner margin, bordered in gray near inner margin; two circles of dorsal surface represented in soft gray ventrally; region of transverse posterior line black, narrowing broadly from costa to thin line or inner margin; distad of black area with white band, fringes dark, as in figure 4. Secondaries pure white, basally black overlain with white hairs; outer marginal band black; fringes apically black, then pure white; ventral surface pure white; intradiscal line black, weakly defined; discal dot also black, weakly defined; outer marginal band a black patch apically, interrupted by a gray area, this gray area containing two small black dots; outer marginal band represented by elongate black patch at hind angle; fringes pure white, hind wing as in figure 4. Abdomen brown-black, intersegmentally with white annuli; ventrally white.

Greatest expanse of forewing 11 mm.

Female: As in male except antennal ciliations shorter. Greatest length of forewing 12 mm to 13 mm. Female illustrated in figure 3.

Specimens examined: 1 male, 2 females, 16 May-28 May, 1963, McDonald Forest, 5 miles northwest of Corvallis, Benton County, Oregon (A. N. McFarland); 2 females, Sonoma County, California.

A. casta is most closely related to *A. miona* Smith as seen by both the male and the female genitalia. There is no problem in superficially distinguishing between *casta* and *miona*, as *miona* possesses yellow-orange secondaries and inhabits the Sierra Nevada range of central and northern California, whereas *casta* possesses pure white secondaries and inhabits the coast and lesser inner ranges, not to mention the great difference in size between the two species. (Fig. 8)

A. casta may be superficially distinguished from *diva*, as *diva* possesses creamy white secondaries and is somewhat smaller. The greatest length of the forewing in *diva* varies from 9 mm to 11 mm, whereas in *casta* it varies from 11 mm to 13 mm. For further points of differentiation between *casta* and *diva*, see Rindge & Smith (1952). (Figs. 5 and 6)

As far as the author is concerned, the supposedly solved problem as to where the type locality of *casta* is located is still dubious as it appears in the literature. The original description by Henry Edwards in 1890 states "Oregon Camp No. 9" as the type locality. When

Hampson discussed *casta* in his Catalogue of the Noctuidae in the collection of the British Museum, he had his choice of two camp nines of Walsingham's western United States trip for the type locality of *casta*, and he chose the California Camp 9. He stated the type locality "Hab. U.S.A., California, Mendocino Co., Rancheni Creek (Walsingham) . . .". No date of capture of the type specimen is given. Rindge and Smith state in brackets "Rancheria" following their quote of Hampson's "Rancheni" Creek in Mendocino County. There is no "Rancheni" Creek existing in this area today, at least, but perhaps nearly 100 years ago it did go under this name. There is a Rancheria Creek in this area now which is a tributary of the Navarro River, and this is unquestionably the creek being referred to. The other "Camp 9" is in Oregon, near Oakland. In the details copied from Walsingham's diary by J. H. Durrant, Camp 9 — "(Caught up wagon) near Oakland 28-IV-1872."

To add to the confusion, Essig (1941) stated for the California Camp 9: "Camp 9. Clearing in redwoods near Navarro River, Mendocino Co., Cal. 29-V-1871." This is correct for the California Camp 9, but is not where *casta* was collected.

Through the kindness of Mr. W. H. T. Tams of the British Museum, the author has before him photostatic copies of Walsingham's personal maps from his library notes as copied by Durrant. These maps cover from below San Francisco Bay, California northward into Washington Territory, and from the Pacific Ocean eastward to mid California and containing all Oregon to Idaho Territory. Unfortunately, the author is unable to reproduce the maps here as the photostatic copies are blurred in places.

As can be seen on the Oregon section of the map, Walsingham marked an "X" to the south of Oakland, between Oakland and Roseburg for his camp 9 where he undoubtedly collected his specimens of *casta*. Mr. McFarland collected his specimens of *casta* in the McDonald Forest, five miles northwest of Corvallis, Oregon. The terrain near Oakland is, in part, very much the same as that found around Corvallis to the north. Both the Oakland and the Corvallis localities are located at approximately the same altitude and are situated equally as far inland from the Pacific Ocean.

In the company of Mr. William Bauer, the author extensively collected the Rancheria Creek area to the "Clearing in redwoods" area along the Navarro River from early March to late in May in the years 1956 through 1960. No *Annaphila casta* were believed to have been seen and none were collected, although *diva* was taken frequently.

There are 2 female specimens of *casta* contained in the American Museum of Natural History collection which the author has examined and they are undoubtedly *casta*. The interesting point is the



Fig. 3. *A. casta*, female, dorsal aspect. Same locality and collector as in figure 1, collected 28 May 1963.

Fig. 4. *A. casta*, male, dorsal aspect. Same data as in figure 1.

Fig. 5. *A. diva* Grote, female, dorsal aspect. Near Feather River, North of Elephant Butte, Plumas County, California, 5 April 1960 (W. R. Bauer & J. S. Buckett).

Fig. 6. *A. diva*, male, dorsal aspect. Spring Mountain, Sonoma County, California, 31 March 1959 (W. R. B. & J. S. B.).

Fig. 7. *A. lithosina* Henry Edwards, female, dorsal aspect. Same locality as figure 5, collected 11 June 1959 (J. S. B.).

Fig. 8. *A. miona* Smith, female, dorsal aspect. Johnsville-LaPorte Road, 14 miles southwest Johnsville, Plumas County, California, 12 June 1961 (W. R. B. & J. S. B.).

data on these specimens: "Sonoma Co. May Cal." and "Sonoma Co. May Calif." The presence of these two specimens is the only supporting evidence of the possibility the "Oregon, Camp 9" of Walsingham might have been in California.

In reference to the California Camp 9, Essig further states, "Caught a small?? *Cerostoma* sp. white—smaller than the last species ghost moth—6 spms. (specimens)." This statement of Walsingham's as copied by Essig may be what confused workers into thinking these Plutellids were the specimens of *casta*. Essig later states in regard to the Oregon section of this trip: "Excepting for the map and the few remarks by Carrier, information concerning the trip through Oregon is not available at this time." Therefore, we do not have the Oregon notes to compare to the California notes. Edwards had 10 female specimens of *casta* before him at the time of his original description, whereas Hampson (1910) had only 8 female specimens in the collection of the British Museum for his research in preparation of the "Catalogue". According to Walsingham, he collected only *six* specimens at the California Camp 9 which could only vaguely suggest *casta*. I doubt that Walsingham, a microlepidopterist, mistook *casta* for a Plutellid or that he miscounted his specimens!

According to the photostatic copies of the maps the author received from Mr. Tams, the map Essig pictured is not the original one used by Walsingham. Essig implies the Oregon map he pictured (which is an 1881 edition) is the one Walsingham used by "Excepting for the map . . ." and "on examining the map it will be seen . . .". These statements appear directly below the map he pictures. In relation to the Oregon Camp 9, Essig states: "Camp 9 may have been set up at Roseburg or vicinity . . .". On the author's photostatic copy, there can be plainly seen an "X" marked in Walsingham's route just below Oakland, Oregon.

Judging from all the information before the author, the type locality of *Annaphila casta* should read: "near Oakland, Oregon, 28 April 1872 (Walsingham)".

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THE GENERIC, SPECIFIC AND LOWER CATEGORY NAMES OF THE NEARCTIC BUTTERFLIES

PART 4 — *The Genus Euptoieta*

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SINCE ITS ERECTION, the generic name *Euptoieta* of Doubleday [1848] has virtually been universally applied to this small group of butterflies. Dos Passos (1964, p. 96) has included it in his listing for the subfamily Argynnninae.

Prior to Doubleday's generic name, butterflies of this group have appeared under the generic names: *Papilio* Linnaeus, 1758; *Argynnis* Fabricius, 1807; *Dryas* Hubner, [1807]; and *Brenthis* Hubner, [1819].

FOOTNOTES

1. Hemming, 1936-1943. Jour. Soc. Bibliog. Nat. Hist. 1: 335-464. Gives publication dates for Genera Diur. Lepid.
2. Copy of work received at Boston Soc. Nat. Hist. Library (now Allan Hancock Found. Library, Univ. of So. Calif.) on 13 Feb. 1875.
3. Hemming, 1958. Official List Works Approv. Avail. Zool. Nomencl. 1st. Install.: 9-10. Gives dates for Cramer's work.
4. Amer. Nat. 6: 354-359. Work is reviewed in June 1872 number.
5. Title page sign, date is 1793. [Preface] sign, date (p. [iv] is 28 Aug. 1793. Page [488] is dated 1793.

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DOS PASSOS, C. F., 1964. A synonymic List of the Nearctic Rhopalocera. Lepid. Soc. Memoir (1): i-vi, 1-145.

LIST OF GENERIC NAMES USED OR AVAILABLE FOR EUPTOIETA

EUPTOIETA DOUBLEDAY. [2 June 1848]¹. In Doubleday and Hewitson. Genera Diur. Lepid. 1(20): 169-170. The text was begun 1(19): 168, no. XI, but included no species names, so that the generic name must be dated from Pt. 20. Doubleday lists two species: *Eupt. hegesia* and *Eupt. claudia* both indicated as authored by Cramer under the generic name *Papilio*. Spelled *Euptneta* by W. Edwards, "1874" [13 Feb. 1875]² in Hayden, Ann. Rept. Geol. and Geogr. Surv. Terr. for 1873, p. 542.

Type: *Pap[ilio]*. *Nymph[alis]*. *Phalerat[us]*. *claudia* Cramer. [1776]³. Uitland, Kapellen Voorkom. Drie Waereld-Deelen Asia, Africa en America 1(8): 152 and 1(6): 109, no. fig. E-F; plate 69, figs. E-F.

Type Selection, Scudder, 1872 [June]⁴. Syst. Rev. Some Amer. Butt., pp. 22-23. Says of *Euptoieta*: Type *Papilio Claudia* Cram. "

LIST OF SPECIES AND LOWER CATEGORY NAMES USED OR AVAILABLE FOR EUPTOIETA

1. EUPTOIETA CLAUDIA (CRAMER).

albaclaudia Field.
claudia (Cramer).
daunius (Herbst).
dodgei Gunder.
fumosa Field.
mariamne (Scudder).

2. EUPTOIETA HEGESIA (CRAMER).

columbina (Fabricius).
hegesia (Cramer).
 • hoffmanni (Comstock).

1. EUPTOIETA CLAUDIA (CRAMER).

albaclaudia, Euptoieta claudia Field, June 1936, Jour. Ent. and Zool. (Pomona College) 28(2): 23, "Holotype male, ... Miama, Fl-[orida]., Jan. 27, 1934, ... Paratype male, Cheboygan Co., Michigan, July 21, 1935, ... Types in author's collection."

claudia, Papilio. Nymphalis. Phalerat[us]. Cramer. [1776]3. Uitland. Kapellen Voorkom. Drie Waereld-Deelen Asia, Africa en America 1(8): 152. The butterfly (without full name) was described on p. 109 (no. fig. E-F) and illustrated on plate 69 (figs. E-F) in Vol. 1, part 6. No sex, series nor date data given. "Men vindt ze op Jamaika."

daunius, Papilio Herbst. 1798. Natursyst. Aller Bekannten in- und Ausländischen Insecten. Der Schmetterlinge 9: 184-185, no. 11; plate 256, figs. 1-2. No sex, series nor date data given. "Ich habe diesen Schmetterling aus Ostindien erhalten." Spelled daunus by Barnes and McDunnough, Feb. 1917, Check List Lepid. Bor. Amer., p. 7, under no. 151.

dodgei, Euptoieta claudia Gunder. 4 May 1927. Ent. News 38(5): 135-136, no. 6; plate 2, fig. 6. "Holotype ♀; ... near Schriber, Dodge County, Nebraska, July, 1885; type in the coll. of Mr. E. A. Dodge, Santa Cruz, Calif., who at a later date may deposit same in the Acad. Coll. at San Francisco."

fumosa, Euptoieta claudia Field, June 1936. Jour. Ent. and Zool. (Pomona College) 28(2): 22-23. "Holotype female, ... Hatfield, Ark[ansas]., Aug. 20, 1934. Allotype male, Eureka, Kansas, Summer 1934, ... Types in author's collection."
mariamne, Papilio Scudder, 1 Feb. 1889. Butt. East. U. S. and Canada 1(4): 519. The name was inadvertently proposed when the author listed Abbot's Ms. name in the synonymy of Euptoieta claudia.

2. EUPTOIETA HEGESIA (CRAMER).

columbina, P[apilio]. N[ymphalis]. Fabricius, 1793 [after 28 Aug.]⁵. Ent. Syst. 3(1): 148, no. 453. No sex, series nor date data given. "Habitat in America Mus. Dom. Jones,"
hegesia, Papilio. Nymphalis. Phaler[atus]. Cramer, [1780]³. Uitland, Kapellen Voorkom. Drie Waereld-Deelen Asia, Africa en America 3(24): 175. The butterfly (without full name) was described on page 30 (no. fig. E-F) and illustrated on plate 209 (figs. E-F) in Vol. 3, part 18. No sex, series nor date data given. "Mon vindtze in Noord-Amerika, en Nieuwjork, en op het Eiland Jamaika."
hoffmanni, Euptoieta hegesia W. P. Comstock, 12 Oct. 1944. Scientific Surv. Porto Rico and Virgin Islands 12(4): 446; fig. 6 (page 444). Type series: 13 ♂ 7 ♀ all from Mexico are in the collection of the Amer. Mus. Nat. Hist. except one paratype in the collection of Frank Johnson. The holotype ♂ and allotype ♀ are from Escuinapa, Sinaloa (no date given). Other locales include Amatian, Tepic; Cordoba; Compestela, Nayarit (Sept. 20, 1933); Jalapa; Jalisco; Mazatlan; Monterey (June 17, 1935); Mexico; Banderes Bay (Nov. 15, 1935); Tezonapa, V. C. (May, June 7, 9, Oct. 8, 1905); and Chiapas.

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NEW CANADIAN SPECIES OF LEAF-MINING LEPIDOPTERA OF CONIFERS

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INVESTIGATION OF LEAF-MINING LEPIDOPTERA on conifers, conducted by myself and several officers of the Canada Department of Forestry, have revealed the presence of several new species. These are described here as a preface to subsequent papers dealing with their life histories in more detail than the characteristic behaviour of some immature stages included in these descriptions. All the species of the genus *Pulicalvaria* Freeman have almost identical genitalia but may be recognized by the habits of the immature stages, and to a lesser extent by differences in maculation. The genus is well characterized by its peculiar male and female genitalia (Figs. 1, 2). As far as is known, it is restricted to coniferous trees in North America, and each species is restricted to a single plant species or to closely allied species within a plant genus.

This paper deals with six undescribed species of the gelechiid genus *Pulicalvaria* Freeman, one of the gelechiid genus *Eucordylea* Dietz, and one of the tortricid genus *Epinotia* Hubner.

GELECHIIDAE

***Pulicalvaria martini* Freeman, new species**

Figs. 1, 2, 3

GENERAL. — Antenna with black and ochreous-white bands. Second joint of palpus with white inwardly, and with two patches of black and ochreous scales outwardly; terminal joint white, with a subbasal and subapical black band. Head shining ivory white, sometimes slightly ochreous on vertex. Thorax ochreous with two minute, anterior black dots and a minute posterior one on scutellum. Forewing shining black, with fawn-coloured scales below fold extending from base to near middle of trailing mar-

gin; a slightly outwardly oblique white fascia at costal third extending to fold; a white, median costal spot; an outwardly-angled, transverse white fascia at outer fourth; apical fringe grey, speckled with black, apical scales white-tipped; trailing fringe leaden grey. Hind wing black; fringe leaden grey. Male with pale-ochreous hair-pencil extending from beneath base of hind wing (Fig. 1). Legs black, banded with white; hind tibia and tarsus pale ochreous inwardly. Wingspread 9-10 mm. Moth in late May and early June.

MALE GENITALIA (Fig. 2). — Uncus subspherical, with long, lateral coarse hairs directed anteriorly; gnathos with median, pendulous hook-like process, and two lateral flange-like processes; tegumen elongate, truncate apically, without lateral lobes; claspers long, tubular and twisted, the left one aborted; aedeagus short, arcuate, and membranous; vinculum produced apically into two tapering sicae, and with a lobate protrusion on right side.

FEMALE GENITALIA (Fig. 3). — Ovipositor lobes membranous; posterior apophyses very long and thin; anterior apophyses much shorter and stouter; ventral plate extended anteriorly into a pair of short processes; ductus bursae short, containing a small sclerotized plate near the ostium; signum spinose, conical.

HOLOTYPE. — Male, Ancaster, Ontario, 23 June 1961 (Freeman and Lewis). Reared from *Picea abies* (L.) Karst. No. 7780 in the Canadian National Collection, Ottawa, Ontario. **Paratypes**. — Ninety males, 107 females, Ancaster, Ontario, 19 May — 2 June 1961 (Freeman and Lewis). Reared from *P. abies*.

DISTRIBUTION. — Known only from Ancaster and Simcoe, Ont.; Hull, Que.; and Bar Harbor, Me.

FOOD PLANTS. — *Picea abies* (L.) Karst. (Ont. rearings); and *P. glauca* (Moench.) Voss. (Que. and Maine rearings).

BEHAVIOUR. — The first-instar larva mines from the tip of the leaf down one side about one-quarter the length. The second-instar larva enters the tip of another leaf and mines downward to about one-half or two-thirds of the length of the leaf. Most of the frass is ejected from these mines. The larva leaves this leaf, enters another near the base, and mines almost to the tip. A silk tube or tent is constructed at the mine entrance and the frass is deposited on, and adheres to the silk. As additional leaves are mined from the base, the silk tent is continued along the twig to each new mine entrance, and the frass continues to be placed on the silk. The larva overwinters beneath the frass-covered tent. It continues mining in the same manner in the spring. The



Fig. 1, dorsal view of head, thorax and hair-pencils of *Pulicalvaria martini*. Figs. 2, male; 3, female genitalia of *P. martini*. Figs. 4, male; 5, female genitalia of *Eucordylea albicostata*. Fig. 6, male genitalia of *Epinotia balsameae*.

larvae occur on young trees in shady locations. In the laboratory, pupation occurred within the frass-covered tube.

REMARKS. — The black forewing, with the fawn-coloured area behind the fold, resembles *P. laricis* new species. (See below). However, the smaller size of *martini* and the characteristic larval behaviour distinguish this species from *laricis*. The larva of *martini* has reddish, transverse abdominal bands. The head and prothorax are light amber. This species is named in honour of the original collector Mr. J. E. H. Martin, Entomology Research Institute, Canada Department of Agriculture, Ottawa.

***Pulicalvaria granti* Freeman, new species**

GENERAL. — Antenna alternately marked with black and ochreous bands. Palpus white. Face and vertex shining white. Forewing white, sprinkled with light ochreous-tipped scales; basal fifth of costa black, the black colour sometimes extending obliquely outward to fold, or broken into blackish spots; just beyond middle of costa, a broad black band extending obliquely outward to fold, and continuing narrowly along fold, there joining a similar band at outer quarter; near trailing margin two small black spots, almost opposite the two black bands; outer black band margined outwardly with white scales; apical portion of wing with small black dots along costal and trailing margins; fringe light grey. Hind wing and fringe light grey. Male with a light-ochreous hair-pencil extending from beneath base of hind wing. Legs white; hind tibia and tarsus with strikingly black bands. Wingspread 9.0-9.5 mm. Female with markings as in male, but with more ochreous ground colour. Moth in early July.

GENITALIA. — Similar to those of *P. martini*.

HOLOTYPE. — Male, Boswell, British Columbia, 29 June 1960. Reared from *Abies grandis* (Dougl.) Lindl. (Forest Insect Survey rearing). No. 7973 in the Canadian National Collection, Ottawa, Ontario. PARATYPES. — Two males, one female, Boswell, B. C., 29-30 June 1960. Two males, West Creston, B. C., 2 and 8 July 1959. All reared from *Abies grandis*.

DISTRIBUTION. — Known only from southeastern British Columbia.

FOOD PLANT. — *Abies grandis* (Dougl.) Lindl.

BEHAVIOUR. — The larva enters a leaf from the undersurface, often near the apex, or between the apex and the middle. Usually there is only one hole in each leaf, and all frass is ejected. The larva overwinters in a leaf, and resumes mining the previous year's growth in the spring. Several leaves are mined and loosely

tied together with silken strands. A favorite mining location is where the leaves of adjacent twigs overlap.

REMARKS. — This species closely resembles the eastern spruce feeder *P. piceaella* (Kft.), but may be distinguished from it by the more pronounced black bands in the forewing and the larval habits. It is named in honour of Mr. James Grant, Division of Forest Insects, Vernon, B. C., who collected the specimens.

***Pulicalvaria macleodi* Freeman, new species**

GENERAL. — Antenna alternately marked with ochreous and brown bands. Palpus light ochreous, second joint with basal and subapical brownish spots; apical joint with a brownish sub-basal band and a black subapical ring. Face and vertex shining whitish. Thorax and ground colour of forewing ochreous white. Forewing with an oblique black streak, extending from base of costa to just beyond fold, terminating in a small patch of raised scales; just before middle, another transverse black band extending less obliquely to middle of wing; opposite this, and just below fold, another small black spot of raised scales; on costa at outer third a rather broad, blackish transverse band narrowly bordered with white apically, and continuing across wing to form a V; around apex of wing are five or six small black dots; apical fringe grey, trailing fringe somewhat lighter. Hind wing and fringe light grey. Fore- and mid-legs with black and cream bands. Hind legs cream, with some black bands on tarsi. Wingspread 9-11 mm. Male with an ochreous hair-pencil arising from beneath base of hind wing. Moth in late May and early June.

GENITALIA. — Similar to those of *P. martini*.

HOLOTYPE. — Male, Twin Elm, Ontario, 26 May 1961 (Freeman and Lewis). Reared from *Tsuga canadensis* (L.) Carr. No. 7972 in the Canadian National Collection, Ottawa, Ont. PARATYPES. — Six males, one female, Twin Elm, Ont., 23-26 May 1961 (Freeman and Lewis). Two males, one female, Prescott, Ont., 26 May-12 June 1961 (Freeman and Lewis). Two males, two females, South March, Ont., 21 May-13 June 1961 (Freeman and Lewis). Five males, two females, Normandale, Ont., 16-23 May 1961 (Freeman and Lewis). All reared from *Tsuga canadensis*.

DISTRIBUTION. — Known only from southern Quebec and southern Ontario.

FOOD PLANT. — *Tsuga canadensis* (L.) Carr.

BEHAVIOUR. — The larva at first mines one or two leaves, entering near the base. It overwinters in a mine and resumes feeding in the spring. Six or more leaves, sometimes from overlapping

branchlets, are mined and tied loosely together. An elongate silk tube is constructed on the underside of the branchlet joining the bases of the mined leaves, and all frass is ejected from the mines. As the larva approaches maturity it hollows out the leaves from the undersurface, apparently being too large to mine the very thin hemlock leaves. Pupation occurs in the silk tube in late May. This behaviour is similar to that of the *Tsuga* feeding sympatric species *P. abietisella* (Pack.). Rather limited observations show that *macleodi* overwinters in a later instar than *abietisella*, and is therefore, larger at that time. In consequence, a few more leaves are mined before winter.

REMARKS. — The adults are much less ochreous than those of *abietisella*. The larva is reddish brown, not green as is that of *abietisella*. This species is named in honour of Dr. J. M. McLeod, Department of Forestry, Sillery, Quebec. Dr. McLeod was the first to observe that in Quebec material two differently coloured larvae were present on *Tsuga*.

The specific names *attritella* Walker (1864, Cat. Lep. Het. Brit. Mus.) and *abietisella* Packard (1884, Rept. U. S. Dept. Agri. p. 150) have for some years been placed in the synonymy of *Recurvaria apicitripunctella* Clemens (1860, Proc. Acad. Nat. Sci. Phila. p. 165). I have examined a coloured photograph of Walker's female type in the British Museum, London, and one of Clemens' type in the Academy of Natural Sciences, Philadelphia. These specimens are undoubtedly allied to the two species mentioned above, but they do not quite match them in maculation. Neither Clemens nor Walker made any mention of the food plant, and Clemens didn't even state the locality, although his type might have been collected in Pennsylvania or in Virginia. I cannot apply *attritella* or *apicitripunctella* with certainty to any of the species. I am familiar with. Therefore, I am using Packard's name. His description fits exactly the species that has a green larva.

***Pulicalvaria laricis* Freeman, new species**

GENERAL. — Antenna alternately marked with black and ochreous bands. Second joint of palpus white, with two black spots outwardly, one near base, the other near apex abutting on a small patch of fawn-coloured scales; terminal joint black with white apex and a white band near middle. Face and vertex shiny white. Thorax of male light fawn with shiny black scales at bases of tegulae; of female mottled light grey and black. Forewing shiny black, interspersed with fawn-coloured scales, particularly in anal half of wing, and along two-thirds of trailing

margin; an outwardly oblique white fascia at basal quarter extending from costa to just beyond fold; another outwardly oblique white fascia extending from middle of costa almost to trailing margin; another outwardly angled, white, transverse fascia at apical quarter; beyond this, tips of scales fawn coloured; six or seven small black dots extending around apical margin; a raised black-and-white scale patch at basal quarter in fold; a pair of black-and-white submedian patches, and another similarly coloured pair at outer third; apical fringe fuscous, with tips of some scales fawn coloured; posterior fringe silvery grey. Hind wing light grey; fringe silvery grey. Male with a long, light-ochreous hair-pencil extending from beneath base of hind wing. Fore- and mid-femur and tibia black with whitish patches; hind femur cream coloured, with black patches outwardly; tarsus with black and whitish bands. Wingspread 10.5-13 mm. Moth in July.

GENITALIA. — Similar to those of *P. martini*

HOLOTYPE. — Male, Ottawa, Ontario, 27 May 1960 (Freeman and Lewis). Reared from *Larix laricina* (Du Roi) K. Koch. No. 7977 in the Canadian National Collection, Ottawa, Ont.

PARATYPES. — Four males, three females, Ottawa, Ont., 16 May - 7 June 1960 (Freeman and Lewis). One male, Pleasant Harbour, Ont., 27 July 1951, F. I. S. 051-1409A. One female, Stittsville, Ont., 24 July 1939 (G. A. Hobbs). All reared from *Larix laricina*.

DISTRIBUTION. — Known only from the above localities in Ontario.

FOOD PLANT. — *Larix laricina* (Du Roi) K. Koch.

BEHAVIOUR. — The larva starts mining in mid-summer from the base of the leaf. One or two leaves are partly mined, and some frass is left in the mine. In the fall a few leaves are tied with silk horizontally along the twig, where most of the frass has accumulated, and the larva hibernates under these leaves. In the spring the larva ties some young leaves into a bundle, and feeds on the apical portions in much the manner as *Argyrotaenia pinatubana* (Kft.). It may pupate in this bundle or form a new one nearby for pupation.

REMARKS. — The adult maculation resembles that of the *Picea*-feeding *P. martini*, but the moth of *laricis* is larger and has a median white fascia. In *martini* this is reduced to a white costal spot.

***Pulicalvaria carbonaria* Freeman, new species**

GENERAL. — Antenna with alternate black and white bands. Palpus with second joint white; apical joint white, with a sub-apical and a sub-basal black band. Face white. Vertex with

grey, black-tipped scales. Legs with alternate black and white bands. Forewing black, with white oblique fasciae and ochreous scales; basal fourth black, particularly on costa, lighter at trailing margin, and with a black spot of raised scales below fold; beyond basal patch an outwardly-oblique white fascia, bordered outwardly with brownish-ochreous scales, particularly on trailing margin; a short, median, outwardly-oblique white costal streak, bordered outwardly with brownish scales; at apical fourth an outwardly angled, transverse white fascia, followed by brownish-ochreous scales; between outer fascia and basal patch below fold, three almost equidistant black spots; apical fourth with submarginal black dots; apical fringe fuscous, with black scales basally, and with white-tipped scales apically; fringe of trailing margin shiny fuscous. Hind wing fuscous; fringe shiny fuscous. Abdomen black. Male without a hair-pencil beneath base of hind wing. Wingspread 7.5-10.0 mm. Moth in early June.

MALE GENITALIA. — Similar to those of *P. martini*, but with the lobate protrusion on right side of vinculum usually less developed.

FEMALE GENITALIA. — Similar to those of *P. martini*.

HOLOTYPE. — Male, Simcoe, Ontario, 1 June 1960 (Freeman and Lewis). Reared from an ornamental *Juniperus* sp. No. 7975 in the Canadian National Collection, Ottawa, Ontario. PARATYPES. — Seventeen males and 21 females, Simcoe, Ont. (Freeman and Lewis) 31 May - 15 June 1960. Fourteen males and 17 females, Simcoe, Ont. (T. N. Freeman) 29 May - 22 June 1955. All reared from the above *Juniperus* sp.

DISTRIBUTION. — Known only from Simcoe, Ont.

BEHAVIOUR. — The larva starts mining the terminal leaves and the stem in late summer, leaving frass in the mines. It mines from the tip of the branchlet toward the base, and overwinters in the stem or in mined leaves. In the spring the larva continues mining the stem, and hollows out the leaves from the inside. The frass is left in the leaves, along and in the stem. Pupation occurs in late May in a short, frass-covered silk tube on the twig, at the base of the damaged leaves.

REMARKS. — This species somewhat resembles the *Picea*-feeding *P. martini*, but lacks the ochreous shading below the fold and the male hair-pencils.

***Pulicalvaria occidentis* Freeman, new species**

GENERAL. — Antenna alternately marked with white and dark-brown bands. Second joint of palpus white, outwardly marked with a basal and a subterminal brown patch; terminal

joint white with a sub-basal and a subterminal brown band. Face, vertex, and thorax shining white. Forewing white, with ochreous scales scattered in outer three-quarters; costa black from base to an oblique, black fascia at the basal fifth, this extending to just beyond fold; a submedian black streak extending obliquely outward to middle of wing, and terminating below a black costal spot at apical third; an elongate, subapical black patch borders on a round, apical white patch containing a small, central black spot; apical fringe mottled with fuscous and white; trailing fringe greyish. Hind wing and fringe grey. Hair-pencil at base of hind wing absent. Legs with black and white bands. Wingspread 9-11 mm. Moth in late June and early July.

GENITALIA. — Similar to those of *P. martini*.

HOLOTYPE. — Male, Ta Ta Creek, British Columbia, 18 June 1958 (Freeman and Lewis). Reared from *Juniperus scopulorum* Sarg. No. 7974 in the Canadian National Collection, Ottawa, Ontario. PARATYPES. — Seven males, 33 females, Invermere, B. C., 26-30 June 1957. One female, Ta Ta Creek, B. C., 20 June 1958. One female, Dutch Creek, B. C., 22 June 1958. Paratypes reared from *J. scopulorum*.

DISTRIBUTION. — Known only from the above localities in southeastern British Columbia.

FOOD PLANT. — *Juniperus scopulorum* Sarg.

BEHAVIOUR. — The larva starts mining in the summer from the tip of a branchlet toward the base, mining very thoroughly both the leaves and the stem. All frass is ejected from the mine. The larva overwinters in the mine, and continues mining toward the base in the spring. Pupation occurs in the mine in early June, the pupa facing toward a large round exit-hole. A short silk ramp is usually made within the mine, and leads to the exit.

REMARKS. — The maculation resembles that of the eastern *Thuja*-feeding *thujaella* (Kft.), but *occidentis* is paler.

***Eucordylea albicostata* Freeman, new species**

Figs. 4, 5

Recurvaria obliquistrigella: Kearfott, 1903, J. New York ent. Soc. 11: 152, Pl. 9, fig. 2.

GENERAL. — Antenna with alternate black and whitish bands. Palpus with second joint whitish inwardly, black outwardly; apical joint white with black apex and sub-basal black band. Head and thorax smooth; shining ivory-white. Abdomen of male ochreous above; of female shiny leaden coloured. Forewing ochreous-white, with a broad, black longitudinal streak extending from base through center of wing almost to apex; this streak

straight along its anterior margin, somewhat wavy or irregular along its posterior margin; just before middle of costa, a short, black, outwardly-oblique streak; beyond middle a broader, longer, outwardly-oblique, black streak, tapering from costa and extending almost to black longitudinal streak; apical third of wing ochreous-white with scattered small black spots; apical fringe scales speckled with ochreous, grey, and black; fringe of trailing margin shiny grey. Hind wing dirty white with shiny, slightly ochreous fringe. Legs black with ochreous patches and bands. Male with a large ochreous hair-pencil arising from beneath base of hind wing. Wingspread 9-10 mm. Moth in first half of June.

MALE GENITALIA (Fig. 4). — Uncus roof-like; shallowly bilobed apically. Gnathos with a long, pendulous, median hook, and two lateral, elongated processes. Tegumen with two lateral projections, the left one much larger, curved and tapering. Claspers asymmetrical, tubular and tapering; the right one larger, twisted, and with a much recurved apex. Sicae slightly sinuous. Aedeagus large, tubular, and arcuate.

FEMALE GENITALIA (Fig. 5). — In general similar to those of *P. martini*, but with signum cruciform with serrate edges, and with lateral edges folded inwardly.

HOLOTYPE. — Male, Simcoe, Ontario, 6 June 1959 (Freeman and Lewis). Reared from *Juniperus virginiana* L. No. 7970 in the Canadian National Collection, Ottawa, Ontario. PARATYPES. — Three males, seven females 7-21 June 1959. Four males, four females, 13-20 June 1960. All from the same locality and food plant as the holotype.

DISTRIBUTION. — Known only from the type locality and New Jersey. See remarks below.

FOOD PLANT. — *Juniperus virginiana* L.

BEHAVIOUR. — The larva mines in the scale-like leaves, starting at or near the base of a branchlet and mining toward the tip. It overwinters in the mine, and continues feeding in the spring. The mined branchlets are loosely tied together, and most of the frass is ejected from the mine entrance. Occasionally some frass is deposited at the tip of a mined branchlet. When full grown, about the end of May, the larva constructs a frass-covered silk ball between the branchlets or in the apex of a mined branchlet, where it pupates.

REMARKS. — This is the species figured by Kearfott as *obliquistrigella* Chamb. I have examined Chambers' type in the Museum of Comparative Zoology, Cambridge, Mass. It

agrees with Chambers' original description (1872, *Canad. Ent.* 4: 65) and is decidedly unlike the specimen figured by Kearfott from New Jersey.

TORTRICIDAE

***Epinotia balsameae* Freeman, new species**

Fig. 6

GENERAL. — Antenna pale grey. Face and vertex ochreous white. Patagium light grey. Abdomen brown, semi-lustrous, apex white. Forewing dark brown with whitish, geminate costal spots and transverse striae. Costal geminations broadest just before middle and continuing rather faintly across wing directly to trailing margin; about middle of wing the inner pair of fasciae expanding into a patch of white scales; at outer third a pair of white costal geminations, continuing faintly and somewhat obliquely to a faint ocelloid patch near tornus; this patch with some silvery-white scales arranged in one to three short striae; near apex a pair of white, short, costal streaks; fringe shining, leaden fuscous. Hind wing semi-lustrous, leaden brown; fringe greyish brown. Legs semi-lustrous, whitish. Wingspread 7-8 mm. Moth in late May and early June.

MALE GENITALIA (Fig. 6). — Uncus bifurcate. Socii well developed. Clasper broad throughout, scimitar-shaped; sacculus with a cluster of short, stout, spines. Aedeagus straight, stout; cornuti a cluster of elongate spines.

HOLOTYPE. — Male, Aylmer, Quebec, 19 May 1961 (G. G. Lewis). No. 8457 in the Canadian National Collection, Ottawa. **PARATYPES.** — Two males, Stittsville, Ontario, 27 May 1958 (Freeman and Lewis) and 7 June 1959 (Freeman and Lewis). All three specimens reared from *Abies balsamea* (L.) Mill.

DISTRIBUTION. — Known only from the above localities which are near Ottawa, Ontario.

FOOD PLANT. — *Abies balsamea* (L.) Mill.

BEHAVIOUR. — The young larva overwinters in a mine and resumes mining in the spring. Four to six leaves are mined, usually in pairs, each leaf mined from near the base to the apex. Each pair of mined leaves usually has a loose silk tube connecting the mine entrances. After mining one leaf and ejecting all frass, the larva enters an adjacent leaf and then backs through the silk tube into the first mined leaf to deposit frass near the apex of the leaf formerly mined. Pupation occurs in early May in the mine, the pupa facing the mine entrance, or sometimes partially protruding from it.

REMARKS. — On the basis of the male genitalia, this species is closely allied to *Epinotia normanana* Kft. and *E. aridos* Free. *E. balsameae* is darker than the other two species, and is smaller than *aridos*, which has a wingspread of 11 mm., and not 6 mm. as printed in error in the original description (1960, Canad. Ent. Suppl. 16: 30).

NOTICES

AUSTRALIAN BUTTERFLIES, by I. F. B. Common [Jacaranda Pocket Guides], Jacaranda Press Pty, Ltd., 73 Elizabeth St., Brisbane, Australia. 1-131, 1964. many illustrations.

THE BUTTERFLIES OF LIBERIA, by R. M. Fox, A. W. Lindsey, Jr., H. K. Clench and L. D. Miller, Mem. Amer. Ent. Soc., No. 19. Philadelphia, Pa. i-ii, 1-438, 1965. col. plate, many illustrations.

LIVING PUPAE of Hyalophora gloveri, H. cecropia and A. polyphemus for sale. 25 cents each. Jim Oberfoell, Bowman, N. Dakota.

WANT living Cymothoe coccenata, M. H. Ross, Div. Cancer Embryology, Biochem. Research Foundation, Newark, Delaware.

WANT Papilio zelicaon living stock, females or pupae. Will pay for field work or stock. C. G. Oliver, Educational Services, Inc. 108 Water St., Watertown, Mass. 02172.

BUTTERFLIES of the San Francisco Bay Region, by J. W. Tilden [California Nature Guides:12], University of California Press, Berkeley, Calif. 1-88, six color plates, many b. and w. 1965. \$1.75

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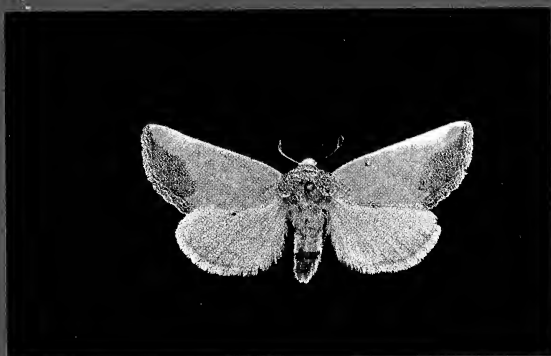
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THE PURPOSE OF THE JOURNAL is to combine in one source the work in this field for the aid of students of this group of insects in a way not at present available. THE JOURNAL will attempt to publish primarily only critical and complete papers of an analytical nature, though there will be a limited section devoted to shorter papers and notes. QUALITY WORK on any aspects of research on the Lepidoptera is invited. Analytical and well illustrated works are preferred, with a minimum of long description.

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A POPULATION STUDY OF A HIBERNAL ROOSTING COLONY OF THE MONARCH BUTTERFLY (*D. PLEXIPPUS*) IN NORTHERN CALIFORNIA

F. A. URQUHART¹, P. BEARD² and R. BROWNLEE³

DURING THE SOUTHWARD MOVEMENT, or fall migration, of the monarch butterfly, temporary roosting sites are established at numerous locations. Such sites are of a transient nature in which the individuals remain for a short period of time, usually for a single night period. We refer to such sites as "transient migratory roosting sites".

On arriving at the over-wintering site, which from our previous studies (Urquhart, 1960) are located along the Gulf of Mexico from Florida to Mexico and parts of Central America and California, the migrants remain as free-flying individuals that are not associated with any definite roosting site, or as transients occupying a roosting site for an indefinite period of time. Some of these roosting sites appear to be of a more or less permanent nature, existing throughout the winter months, as is the case in the Monterey Peninsula, while others occur for a short period of time (Urquhart, 1960). So that we may discuss the variations and dynamics of the over-wintering populations, we refer to the colonies that establish roosting sites for a portion of the winter period as "transient hibernaral roosting colonies" as distinct from those that are of a more permanent nature which we refer to as "hibernaral roosting colonies". The distribution of some of these colonies have been previously located by Williams et al. (1942) and Urquhart (1960).

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Since little is known about the inter-relationship existing between these various over-wintering colonies and observed free-flying individuals, an investigation of a transient colony was undertaken which, together with studies of other colonies now in progress, will present a clearer picture of the over-wintering activities of this insect migrant.

The colony chosen for this investigation is located at Natural Bridges in Santa Cruz, California. The site occupies a grove of red gum eucalyptus trees. The roosting colony is located on the branches of the north central portion of the grove at distances of from six to forty feet above ground level. There are no other groves of trees along this part of the coast that could serve as suitable roosting sites.

The alar tag method (Urquhart, 1960) of individual identification was employed. Over seven thousand specimens were individually tagged during the period October 3 to December 19, 1964. When a tagged specimen had been recaptured and sent to our laboratory, a printed form was mailed to the person sending the specimen requesting the date, time and exact locality of the recapture. The locality was given as the street and house number in Santa Cruz where the specimen had been taken. The research associate who had tagged the specimen was informed of the recapture and a request made for the date and time of tagging. By this procedure, the pertinent information on the movement of a particular individual of a colony could be recorded and entered in our files, along with all correspondence concerning a particular flight record. Recaptured specimens which were not sent to us but simply reported as "having been seen" were considered invalid and were not entered in our research file; only actual tag returns were considered valid.

Referring to fig. 1, it will be noted that there were periods during which few or no recaptures were reported and other periods during which there were many. From observations of free-flying individuals within the area, together with these data, it may be concluded that during periods of suitable weather conditions members of the colony leave the roosting site in order to obtain food from nectar-bearing flowers. Such individuals may return to the same roosting site or they move on to a different locality where they may join a roosting colony or remain free-flying and roosting as solitary individuals during inclement or nocturnal periods.

Recaptures of individuals that had travelled in excess of one mile from the roosting site, but within the same hibernal period

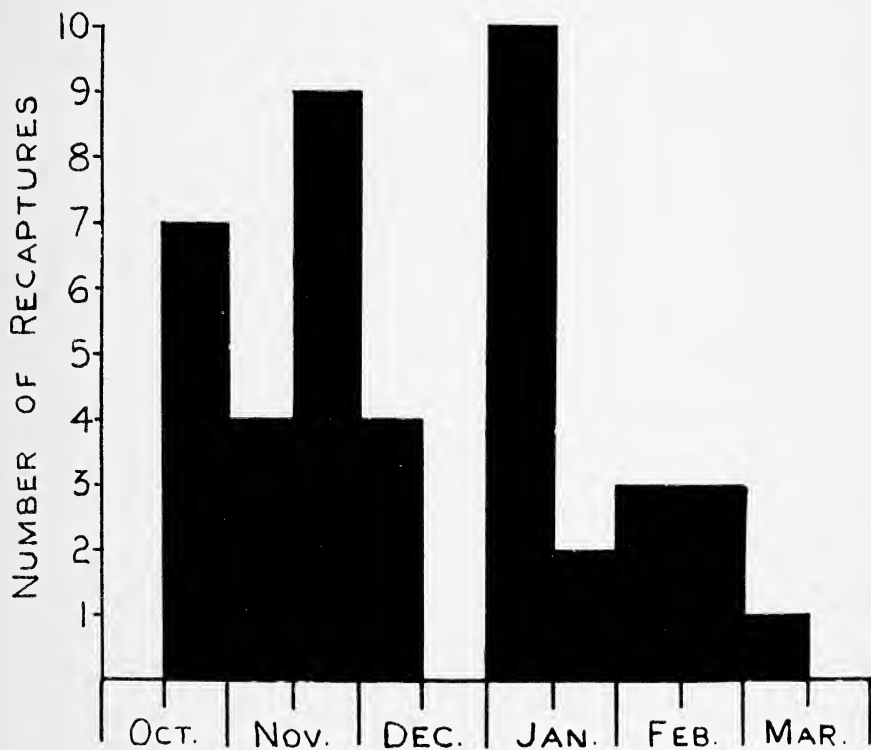


Fig. 1. Number of recaptures correlated with by-monthly time intervals indicating roosting and flight periods within the roosting site area.

and hence were not vernal migrants, show a similar pattern of movement with the exception that the flight period extends beyond the first half of February, thus occupying the entire overwintering period from the end of the autumnal movement to the beginning of the vernal movement.

The direction and distance travelled from the roosting site is indicated in the outline map of Santa Cruz, as shown in fig. 2. It will be noted that recaptures are most abundant to the north-east, between 10° and 60° with a tendency to a more easterly direction, between 60° and 80° for longer distances. This indicates a close relationship between individuals in the other roosting sites within the area and perhaps with those in the Monterey Peninsula and further south.

In addition to these data, observations on the Natural Bridges population indicate a complete withdrawal from the site during the latter half of December. This is correlated with the advance of a cold polar air mass. The physical effect of the cold temperature and frontal storms on members of the colony remaining at this exposed site was observed on December 19 at which time 1980 specimens were found beneath the roosting trees; these specimens, immobilized by the cold temperature and dislodged from the roosting trees by strong winds, were unable to return to the branches of the trees because the wings had become water-soaked (Urquhart, 1965). This was on the first day of a severe frontal storm that lasted intermittently for three weeks accompanied by heavy rain.

From the above data, we may conclude that migrating individuals arriving in northern California from the north and north-east establish transient hibernal colonies at various points where suitable roosting sites are available. Throughout the transient period, individuals leave the colony under suitable weather conditions, to obtain nourishment; such free-flying individuals may or may not return to the original site. Motion away from the site is to the east and south-east — the proximity to the ocean precluding any recorded movement to the west. Since the roosting site is located at the south-westerly portion of the city of Santa Cruz, few returns would be expected from the north-west. That not a single record was made to the north-west, however, would indicate little or no movement in this direction. A complete exodus from the original transient site takes place during the latter half of December and is, presumably, associated with polar air mass advancement. Thus, mem-

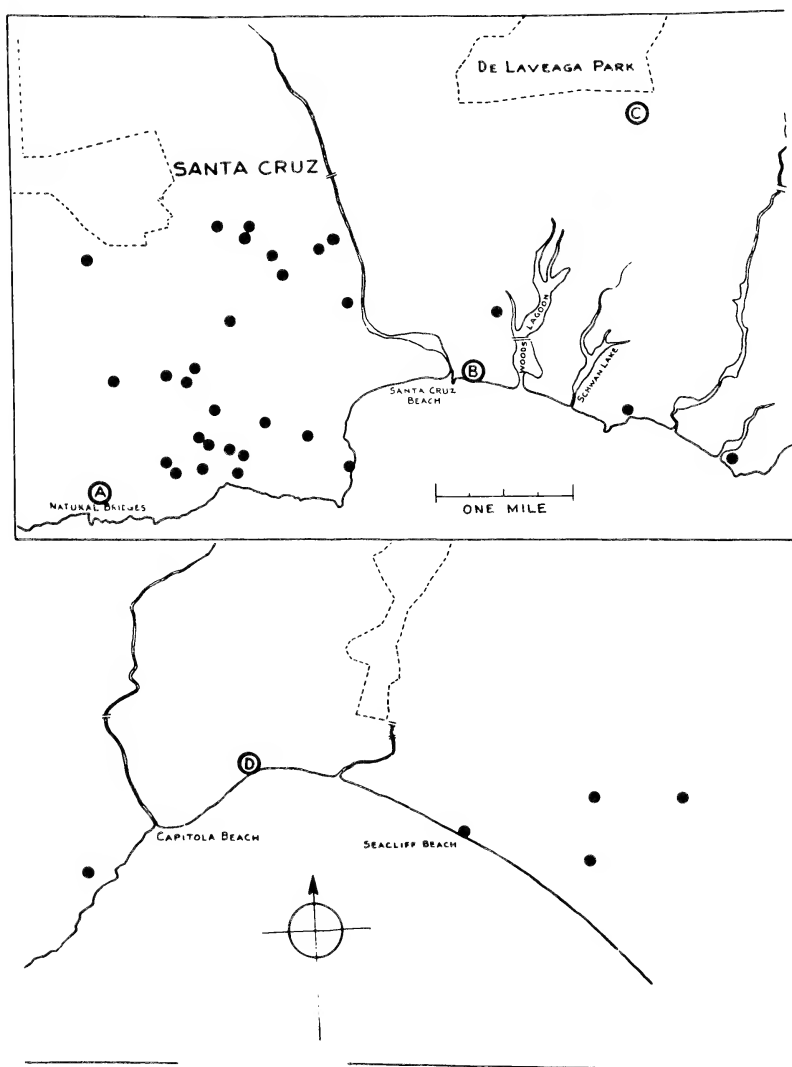


Fig. 2. Map of Santa Cruz, showing location of transient colonies A, B, C, D and recapture records (●).

bers of transient colonies move inland to other more protected sites or southward to other sites or as free-flying individuals.

Migrants from the east and north-east of California enter at various points extending as far south as Los Angeles (Urquhart, 1965). Transient colonies are thus established from Los Angeles, and perhaps as far south as San Diego, to Stinson Beach in northern California. The number of such transient colonies is not known but we assume that many more than now recorded will be located in the interior, particularly in the northern parts of the San Joaquin Valley, in the valleys of the Coastal Range as well as the better known colonies along the coast.

From the data here presented it is concluded that the overwintering monarch butterflies in California represent a single gonotrophic dissociated population. As such, they are active feeders and, for the most part, free-flying; they are not sedentary or in complete diapause. Individuals observed free-flying or as roosting colonies, are transient and as such may establish transient roosting sites during periods of inclement weather or hibernal colonies in which some members are present throughout the winter months, but the numbers of such seemingly permanent colonies vary as movement takes place from this site to another or as individuals remain free-flying. Static colonies, such as those in the Monterey Peninsula, are due to prolonged periods of inclement weather together with the suitability of the roosting site both topographically and the availability of suitable roosting trees (Williams et al, 1942). Such hibernal sites are, in so far as the entire overwintering population is concerned, the exception rather than the rule. We believe that similar overwintering activities as here described will be found with respect to colonies in parts of Florida, the Gulf Coast and Mexico.

ACKNOWLEDGMENT

The writers thank the National Research Council for the support of this work.

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THE LITTLE KNOWN SPECIES

LUPERINA VENOSA

A RE-DESCRIPTION OF THE SPECIES WITH ADDITIONAL DISTRIBUTIONAL DATA

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LUPERINA VENOSA (SMITH) WAS DESCRIBED in 1903 and originally attributed to the genus of *Cosmia* Ochsenhimer. At the time of the original description, Smith had a total of six specimens before him, collected in Oregon, Washington, and British Columbia. Before this present paper, there were apparently no published records of *venosa* from California. Recently the species has been taken in fair abundance near Petaluma, Sonoma County, California, and in the northern portion of the state in the coast ranges.

The only treatment *venosa* has had besides the original description is that by Hampson (1908). Barnes & McDunnough (1917), and McDunnough (1938) list *venosa* in their lists. Oddly enough, Blackmore (1927) failed to include this species in his "checklist" even though British Columbia is a locality included with the original description. Apparently, there is no photograph of the adults in the literature, nor have the male or female genitalia been illustrated. Presented here are both a photograph of the adults and illustrations of the genitalia in both sexes. (Figs. 2-7). Hampson's colored illustrations of *venosa* is very good, the only criticism being that it is slightly too bright.

As can be seen by the distribution map (figure 1), *venosa* occurs along the coast ranges of California, northward into British Columbia. Nothing is yet known concerning the immature stages of this insect, but it probably feeds on one or more grass species, or perhaps on *Rumex* spp. Crumb (1956) mentions the foodplants of

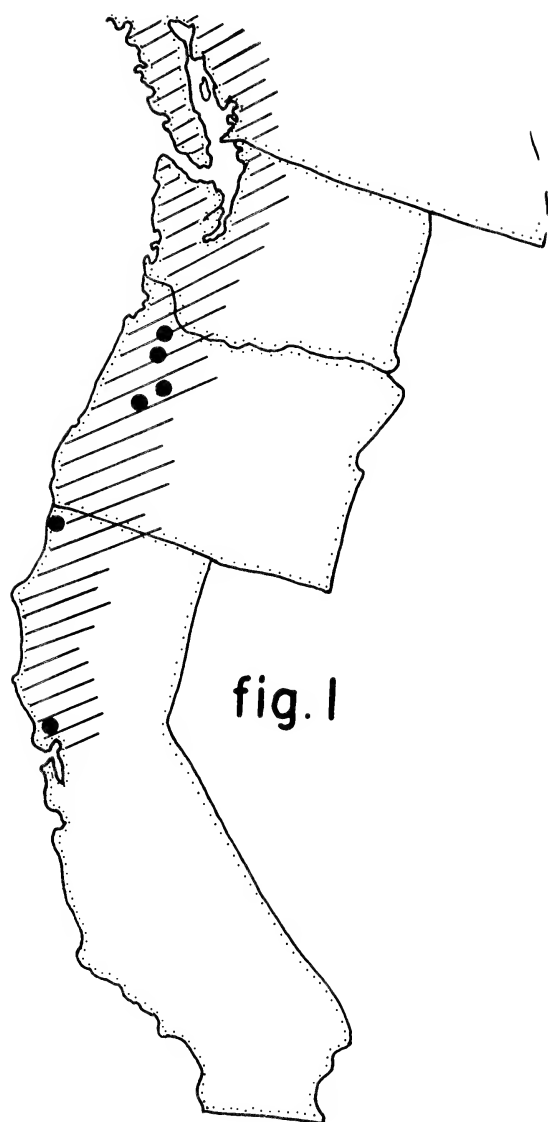


Fig. 1. — Distribution map showing the range of *Luperina venosa* (Sm.).

some of the other species in the genus, and they feed on the plants suggested by the authors for *venosa*. Of the members of the genus in which immature stages are known, there is no indication that would lead one to believe *venosa* to be host specific.

L. venosa flies in June in the southern most portion of its range, and emerges progressively later in the season as one goes northward. It is on the wing for a period of four to five weeks.

Luperina venosa (Smith)

Cosmia venosa Smith, 1903; Jour. N. Y. Ent. Soc. 11(1):21. Hampson, G. F., 1908; Cat. Noctuidae Brit. Mus. 7:467, 475, plate 119, figure 21. Barnes, Wm., and J. McDunnough, 1917; Checklist of the Lepidoptera of Boreal America, pg. 63. Draudt, M. (in Seitz), 1926; The Macrolepidoptera of the World 7:236, figure 34g. McDunnough, J., 1938; Check list of the Macrolepidoptera of Canada and the United States of America. Mem. So. Cal. Acad. Sci. 1:88.

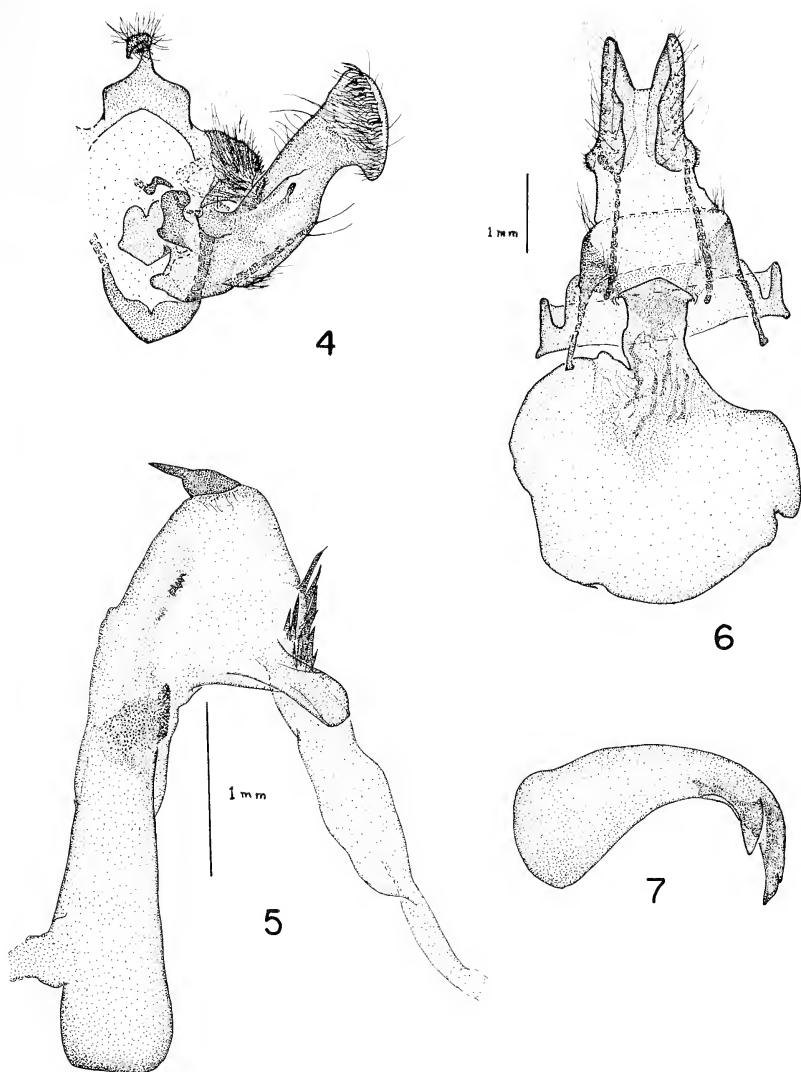
Male: Ground color red-brown, thorax darker than primaries; secondaries and abdomen smokey brown, lighter than thorax. Head with evenly rounded frontal protuberance; antennae with scape exterolaterally produced, flagellum scaled dorsally, ventrally with a single group of setae per each flagellar segment; single pair of ocelli conical, broader at base than terminally; palps clothed in admixture of brown elongate scales and hairs; basal segment of palpi also possessing rose colored scales exterolaterally. Thorax unicolorous, dark red-brown; primaries red-brown; basal line hardly discernable, when present represented on costa in dark brown; transverse anterior line dark brown, with two large undulations in cubital and anal regions; median area darker than both transverse anterior area and subterminal area; claviform dark brown, elongate, traversing one-third the distance across median area; orbicular ochreous, obscured, or prominent, round, or oblong; transverse posterior line dark brown, from directly above reniform on costa thence outwardly curved around reniform, thence straight to inner margin, roughly parallel with outer margin; reniform prominent, ochreous; subterminal line brown, faint; terminal line dark brown; fringes fuscous; ventral surface of primaries dark brown, becoming lighter terminally; suggestion of exterior line; secondaries dorsally dark brown, fringes lighter; ventral surface lighter brown than ventral surface of primaries; discal dot dark, prominent; suggestion of exterior line; venter of thorax dark brown, tarsal segments indistinctly yellow ringed terminally; unguis bifurcate, as in figure 7. Abdomen brown, becoming lighter terminally. Greatest expanse of forewing 18mm-19mm.

Female: More brightly colored than in male; antennae lacking setal groups as in male, scaled dorsally, microciliations ventrally as



Fig. 2. — *Luperina venosa*. Male. 2 miles northwest of Petaluma, Sonoma County, California, 1 July 1963 (L. P. Lounibos).

Fig. 3. — *Luperina venosa*. Female. Same locality and collector as in figure 2, 26 June 1963.



Luperina venosa

Fig. 4. — Male genitalia, minus aedeagus. Same locality and collector as in figure 2, 8 June 1963 (Bauer-Buckett slide No. 65D20-21). Fig. 5 — Aedeagus. Data same as in figure 4. 1 mm indicator near aedeagus applies only to figure 5. Fig. 6 — Female genitalia. Same locality and collector as in figure 2, 18 June 1963 (B.-B. slide No. 65D20-22). Fig. 7 — Left posterior tibial claw, mesal view, showing bifurcation, 40 X. Data same as in figure 4.

well as one or two prominent setae per flagellar segment; tarsi conspicuously yellow banded. Greatest expanse of forewing 17mm-20mm.

SPECIMENS EXAMINED

24 males, 11 females, 2 miles northwest Petaluma, Sonoma County, California, 8 June - 1 July, 1963 (L. P. Lounibos); 2 males, same locality and collector as preceeding, 8 June and 18 June 1963 (Bauer-Buckett Slide No. 65D20-21, and B.-B. slide No. 65D20-23, respectively); 1 female, same locality and collector as preceeding, 18 June 1963 (B.-B. slide No. 65D20-22); 2 males, 1 female, same locality and collector as preceeding, 11 June 1962; 6 males, 5 females, Fort Dick, Del Norte County, California, 25 June - 26 July 1962 (J. W. Anderson); 1 female, Aumsville, Marion County, Oregon, 23 June 1964 (K. Goeden); 1 male, 1 female, 5 miles northwest Corvallis, Benton County, Oregon, 1 July 1962 (A. N. McFarland); 1 female, McMinnville, Yamhill County, Oregon, 6 July 1953 (K. Fender); 1 male, 1 female, same locality and collector as preceeding, 1 September 1953; 6 males, 3 females, Forest Grove, Washington County, Oregon, 10 June 1964 (K. Goeden).

The specimens used in this work are located in the following collections: Bauer-Buckett Collection, Davis, California; Entomology Collection, University of California, Davis; L. Philip Lounibos Collection, Petaluma, California. The methods used in preparing the genitalic mounts and the illustrations are the same as those employed by Buckett (1964), the only modification being the inflation of the aedeagus herein employed. All the specimens, with the exception of the McMinnville specimens, were collected by the use of 15 watt fluorescent black light trap, using Calcium Cyanide as the killing agent.

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CALLOPHRYS (MITOURA) SPINETORUM AND C. (M.) JOHNSONI:

Their known range, habits, variation, and history

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THE PURPOSE OF THIS STUDY was primarily to record the known distribution of *M. spinetorum* (Hewitson) and *M. johnsoni* (Skinner). Correspondence furnished most of the records. There is probably little danger of misidentification of *spinetorum* since it is widely known from the descriptions and illustrations in Comstock (1927) and Holland (1931) and since it is a distinctive hairstreak. However, it was necessary to see *johnsoni* specimens wherever possible or have someone familiar with *johnsoni* make the identification since there is definitely misunderstanding about what the name represents. *M. nelsoni* and *spinetorum* have occasionally been misidentified as *johnsoni*. For example, Jones (1951) records a *johnsoni* from Spuzzum, British Columbia, that turned out upon examination to be *nelsoni*. Also, a "*spinetorum* near *johnsoni*" from Wilson, Wyoming (Nabokov, 1950), proved to be *spinetorum*. Similarity of facies and of foodplant preference (*Arceuthobium*) leads one to believe that *spinetorum* and *johnsoni* are closely related.

HISTORY

M. spinetorum was described by Hewitson in 1867 from one female collected somewhere in California by Lorquin. The type is in the United States National Museum collection. W. H. Edwards described *M. ninus* in 1871 from three males collected by Mead in Colorado. Mead caught the specimens "on the South Park road, four miles from the park, on the 17th of June [1871]", as stated in the Report of the Wheeler Expedition, Zoology, p. 778 (Brown, 1955). This locality is today found ca. 1 mi. E Kenosha Pass summit, U. S. Highway 285, according to Brown (1955). Two of the three *ninus* "types" are in the Carnegie Museum, one of which was designated the lectotype by F. M. Brown in 1965. *M. cuyamaca* was described by W. S. Wright in

1922 from Julian, San Diego Co., Calif. (VIII-4-17, holotype female). I do not know where this specimen is located; it is not in the San Diego Natural History Museum collection. The allotype male of *cuyamaca*, from Cuyamaca Lake, San Diego Co., Calif., VII-7-18, is in the SDNH Museum collection; it is labelled "*Strymon cuyamacha* Type. Wright." It is unfortunate that this specimen is missing antennae and abdomen. A *cuyamacha* paratype from Julian is located in the USNM and is labelled "*cuyamacha*"; the whereabouts of the other four paratypes is unknown. *M. johnsoni* was described by Skinner in 1904 from a female from British Columbia and a male from Seattle, Wash. (ex larva, emerged VII-15-91, leg. C. V. Piper). The types are located in the Carnegie Museum collection.

DISTRIBUTION

In California *spinetorum* is found from near sea level (Monterey Peninsula, Monterey Co., leg. J. C. Spencer) to 8000 feet (Mineral King, Tulare Co., leg. E. Pfeiler). In Colorado it flies from about 6200 feet (Soda Spring, Boulder Co., leg. D. Eff) to 11,000 feet (Squaw Mtn. Meadow, Clear Creek Co., leg. R. J. Jae). The northernmost record is Young Lake, B. C. (leg. W. E. Bitz), and the southernmost record is 6 mi. E. Mexico-Michocan boundary on hiway 45, Mex. (leg. F. G. Hawksworth & D. Wiens). The westernmost record is Cobb, Lake Co., Calif. (leg. F. Cobb, Jr.), and the easternmost record is the above mentioned Mexican locality (the easternmost U. S. record being Star Ranch, El Paso Co., Colo., leg. S. A. Johnson). Since the distribution picture reflects a collecting bias, I should point out that *spinetorum* may turn up where *Arceuthobium* is known to occur in much of Mexico, Guatemala, northern coastal California, extreme western Texas, Vancouver Island, central British Columbia, southeastern Alaska, Alberta, Saskatchewan, Manitoba, north-eastern United States, and southeastern Canada. North American host trees for *Arceuthobium* are all in the family Pinaceae (Kuijt, 1960).

The "Laguna, California" label for the *spinetorum* figured in Ehrlich & Ehrlich (1961) is most likely Laguna Mtns., San Diego Co., Calif. The figured specimen was captured by G. Field who collected in San Diego Co. during that time (1926). One pair in the AMNH labelled "Laguna, Orange Co., Calif., VI-16-26, leg. C. Henne" probably represents a mislabelling because Mr. Henne was not collecting then and furthermore Laguna Beach, Orange Co., is rather distant from any native stand of pines.

VARIATION

Measurements of two *spinetorum* populations were taken (see tables 1, 2). The linear length of the right primary, from costa base to apex, and the length of the thoracic tergum, from anterior edge to posterior point, were measured on spread specimens with a vernier caliper. The ratio of wing length to tergum was used to help minimize differences due to size, although a possible error may be introduced from terga warped by "papering". At the 5 per cent level, the probability that the difference between Rollinsville and Laguna Mtns. populations is due to chance alone is less than 0.001, except for $P = .10+$ in the male ratio. A significant difference was also found between 1960 and 1964 female

TABLE 1 MALE SPINETORUM

Locality	No.	Mean wing length (mm)	Range (mm)	S.D.	S.E.	d	P
Rollinsville, Colo. 8400'	34	13.573	11.4-14.6	.665	.114	9.46	.001-
Laguna Mtns., Calif. ca. 5500'	41	14.982	13.8-16.1	.607	.095		
Locality	No.	Mean tergum length (mm)	Range (mm)	S.D.	S.E.	d	P
Rollinsville, Colo. 8400'	34	4.314	3.2-4.9	.351	.060	10.45	.001-
Laguna Mtns., Calif. ca. 5500'	41	5.056	4.5-5.8	.324	.051		
Locality	No.	Mean ratio of wing length to tergum	Range	S.D.	S.E.	d	P
Rollinsville, Colo. 8400'	34	3.16	2.90-3.80	.783	.134	1.40	.10+
Laguna Mtns., Calif. ca. 5500'	41	2.97	2.65-3.30	.138	.022		

S.D. = Standard deviation; S.E. = Standard error; P = Probability

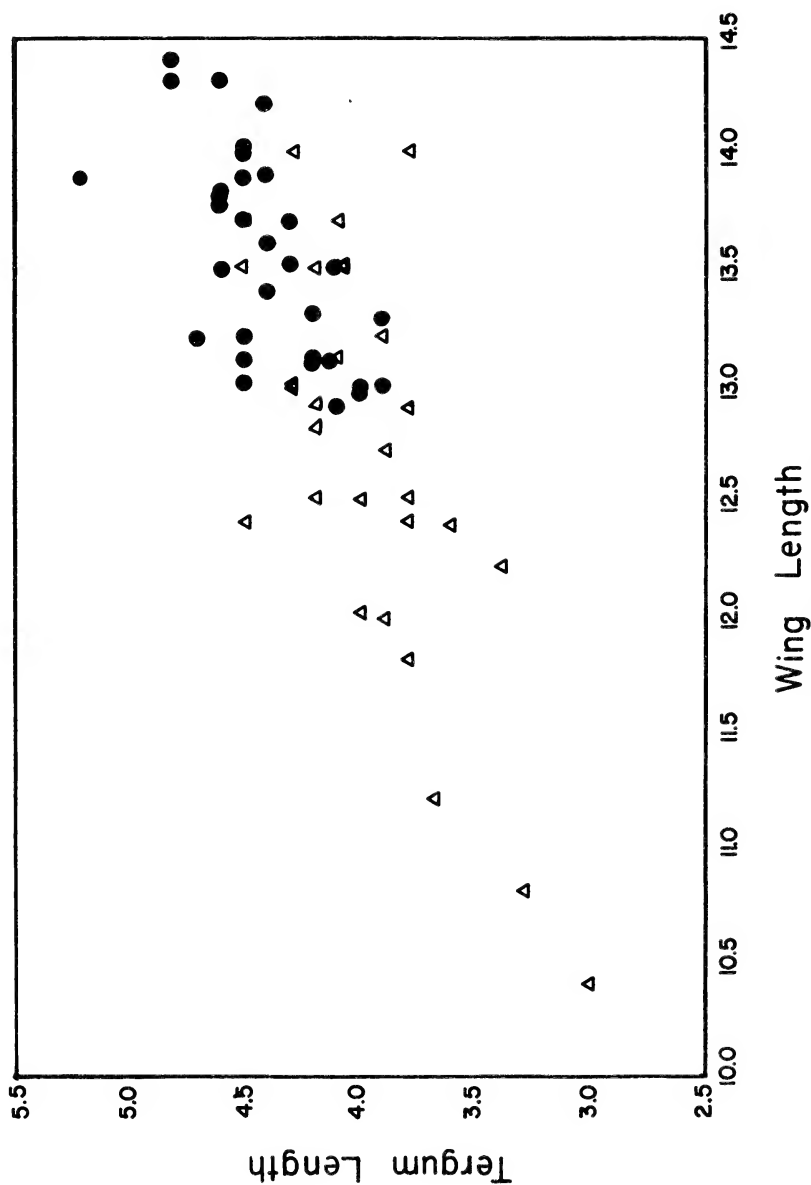


Fig. 1. The relationship between wing length and tergum length in *spinetorum* populations at Rollinsville, Colorado. + = June 14, 1960; 0 = June 23, 1964.

samples of the same spatial population (see table 3 & fig. 1). The summer of 1959, when the 1960 *spinetorum* June crop probably would be feeding, was unseasonably dry in the Colorado Rockies, while the summer of 1963 was unseasonably wet. These weather differences may have affected the size of the specimens in some way, although the evidence is circumstantial and perhaps too general.

HABITS

Larvae of *spinetorum* were first located on *Arceuthobium campylopodum* Engelm. by C. Henne in 1936 (Comstock & Dammers, 1938). Remington (1958) recorded two additional food plants: *Arceuthobium vaginatum* f. *cryptopodum* (Engelm.) Gill, on *Pinus ponderosa* Laws. (leg. F. G. Hawksworth); and *A. americanum* Nutt. ex Engelm., on *P. contorta* Dougl. ex Loud. (leg. T. E. Hinds). Reared adults were obtained. Tilden (1960) reared an adult from a larva found on *A. campylopodum*, on *P. sabiniana* Dougl. ex Don (leg. W. S. Ross). Other host plant records for larvae include the following: *A. campylopodum*, on

TABLE 2 FEMALE SPINETORUM

Locality	No.	Mean wing length (mm)	Range (mm)	S.D.	S.E.	d	P
Rollinsville, Colo. 8400'	78	13.311	10.4-14.8	.808	.091	16.03	.001 ⁻
Laguna Mtns., Calif. ca. 5500'	109	14.994	13.5-16.4	.599	.058		
Locality	No.	Mean tergum length (mm)	Range (mm)	S.D.	S.E.	d	P
Rollinsville, Colo. 8400'	78	3.711	2.5-4.7	.359	.041	24.72	.001 ⁻
Laguna Mtns., Calif. ca. 5500'	109	4.502	3.8-5.3	.277	.027		
Locality	No.	Mean ratio of wing length to tergum	Range	S.D.	S.E.	d	P
Rollinsville, Colo. 8400'	78	3.60	2.95-4.25	.257	.029	5.91	.001 ⁻
Laguna Mtns., Calif. ca. 5500'	109	3.34	2.85-3.80	.485	.047		

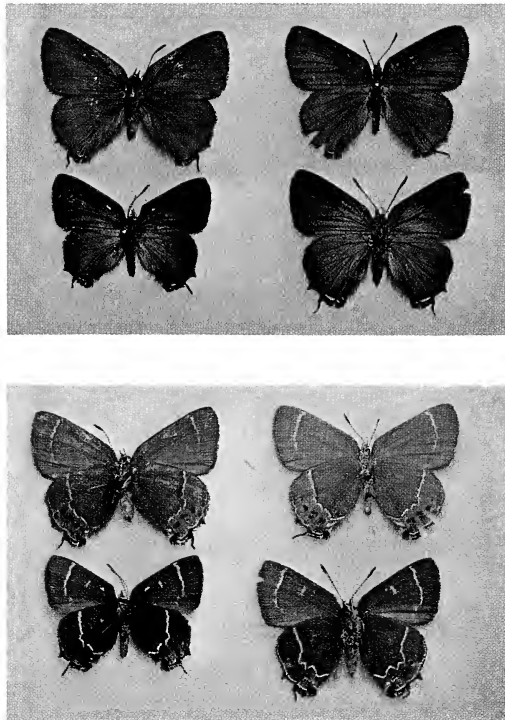


Fig. 2. Plate showing color differences between two populations of *johnsoni* and *spinetorum* females. Average specimens were selected from series for freshness. Upper four, upper side; lower four, lower side. 1. *M. johnsoni*, 1 mi. E Bassets, Sierra Co., Calif., 5460', VI-17-61 (P. A. Opler). 2. *M. johnsoni*, Jerseydale, Mariposa Co., Calif., 3800', VII-24-63 (O. Shields). 3. *M. spinetorum*, Rollinsville, Gilpin Co., Colo., ca. 8400', VI-23-64 (J. A. Justics). 4. *M. spinetorum*, Boiling Springs, Laguna Mts., San Diego Co., Calif., 5500', VI-24-61 (F. T. Thorne). The under side brown of 1 and 4 is rust, linoleum for 2, and liver for 3; colors compared with the Reinhold Color Atlas.

P. jeffreyi Grev. & Balf. (leg. J. C. Downey, J. F. & T. C. Emmel, O. Shields); *A. c. F. abietinum* (Engelm.) Gill, on *Abies concolor* (Gord & Glend.) Lindl. ex Hildebr. (leg. O. Shields); **A. c. F. blumeri* (A. Nels.) Gill, on *P. reflexa* Engelm. (leg. F. G. Hawksworth, P. C. Lightle); **A. c. F. cyanocarpum* (A. Nels.) Gill, on *P. aristata* Engelm. (leg. F. G. Hawksworth, P. C. Lightle); *A. c. F. divaricatum* (Engelm.) Gill, on *P. monophylla* Torr. & Frem. (leg. O. Shields); **A. c. F. laricis* (Piper), Gill on *Abies lasiocarpa* (Hook.) Nutt. (leg. E. F. Wicker, J. Grant); **A. c. F. laricis*, on *Larix occidentalis* Nutt. (leg. E. F. Wicker); and **A. globosum* Hawksworth & Wiens, on *P. michoacana* Martinez (leg. F. G. Hawksworth, D. Wiens). (Larvae not reared to adults = *.) J. W. Tilden collected a female scared up from *Phoradendron* on *Juniperus* at Oak Creek Canyon, Ariz., but no evidence of larvae feeding on *Phoradendron* is yet available (pinyon also occurs in the vicinity).

TABLE 3 FEMALE SPINETORUM, ROLLINSVILLE, COLORADO

Date	No.	Mean wing length (mm)	Range (mm)	t	P
14 June 1960	26	12.634	10.4-14.0	5.18	.001-
23 June 1964	32	13.546	12.9-14.4		
Date	No.	Mean tergum length (mm)	Range (mm)	t	P
14 June 1960	26	3.430	2.5-4.0	5.91	.001-
23 June 1964	32	3.903	3.4-4.7		
Date	No.	Mean ratio of wing length to tergum	Range	t	P
14 June 1960	26	3.70	3.37-4.24	3.74	.001-
23 June 1964	32	3.48	2.96-3.91		

Larvae of *johnsoni* were found on *Arceuthobium campylopodum* f. *tsugensis* (Rosendahl) Gill on *Tsuga heterophylla* (Raf.) Sarg. by C. V. Piper (Skinner, 1904), and larvae and egg shells were found by D. V. McCorkle on *tsugensis*. Adults were successfully reared. As pointed out by McCorkle (1962), the dwarf mistletoe given in Skinner's *johnsoni* type description was probably not *A. douglasii* Engelm. on *Tsuga mertensiana* (Bong.) Sarg. *Tsugensis* is not known to occur at least in several low-elevation California localities, indicating choice of another food-plant.

Spinetorum nectar sources recorded by contributors include *Achillea*, *Allium*, *Anaphalis*, *Antennaria*, *Aplopappus*, *Arctostaphylos*, *Berberis*, *Ceanothus*, *Cymopterus*, dandelion, *Erigeron*, *Eriodictyon*, *Eriogonum*, *Helenium*, *Iris*, *Lomatium*, *Lupinus*, *Polygonum*, *Potentilla*, *Prunus*, *Ribes*, *Rhus*, *Salix*, *Sambucus*, *Senecio*, *Solidago*, *Spraguea*, and thistle. *Johnsoni* sources include *Arctostaphylos*, *Ceanothus*, *Cornus*, dandelion, *Fragaria*, *Rorippa*, and *Spraguea*. Apparent "hilltopping" of male *spinetorum* was seen on a peak top in the Providence Mtns., Calif., and Black Ridge, Colo. (T. C. & J. F. Emmel). Both sexes of *spinetorum* and *johnsoni* are drawn to moisture at various localities. Most Colorado *spinetorum* records are for flowers, while most *spinetorum* specimens in the Laguna Mts., Calif., are taken at moisture and are only occasionally seen on flowers.

Remington (1958) mentioned an unidentified braconid larval parasite and a braconid pupal parasite (an undescribed *Apanteles*) of *spinetorum*. A tachinid larval parasite, *Masphyomyia paralis* Rein, was identified by C. W. Sabrosky; the fly pupates outside the *spinetorum* pupa. Larvae parasitized by *M. paralis* were collected nr. Ackerson Meadow, Tuolumne Co., Calif. (O. Shields), and one larva was collected from Warner Hot Springs Mtn., San Diego Co., Calif. (A. Forbes). A tetrastichid, *Tetastichus* ssp., identified at the USNM, was reared from *spinetorum* pupae from Kingsbury Grade, Douglas Co., Nev., by T. C. Emmel. Several dead *spinetorum* larvae and one *johnsoni* larva have been found with a parasite exit hole. *Spinetorum* adults occasionally have clipped wings and beak-marked wings, indicating bird predation.

ACKNOWLEDGEMENTS

The tremendous cooperation of many individuals during this study was most gratifying. Unfortunately, space precludes mention of all of the contributors, but those who sent records whose names are not mentioned in the record section include A. E.

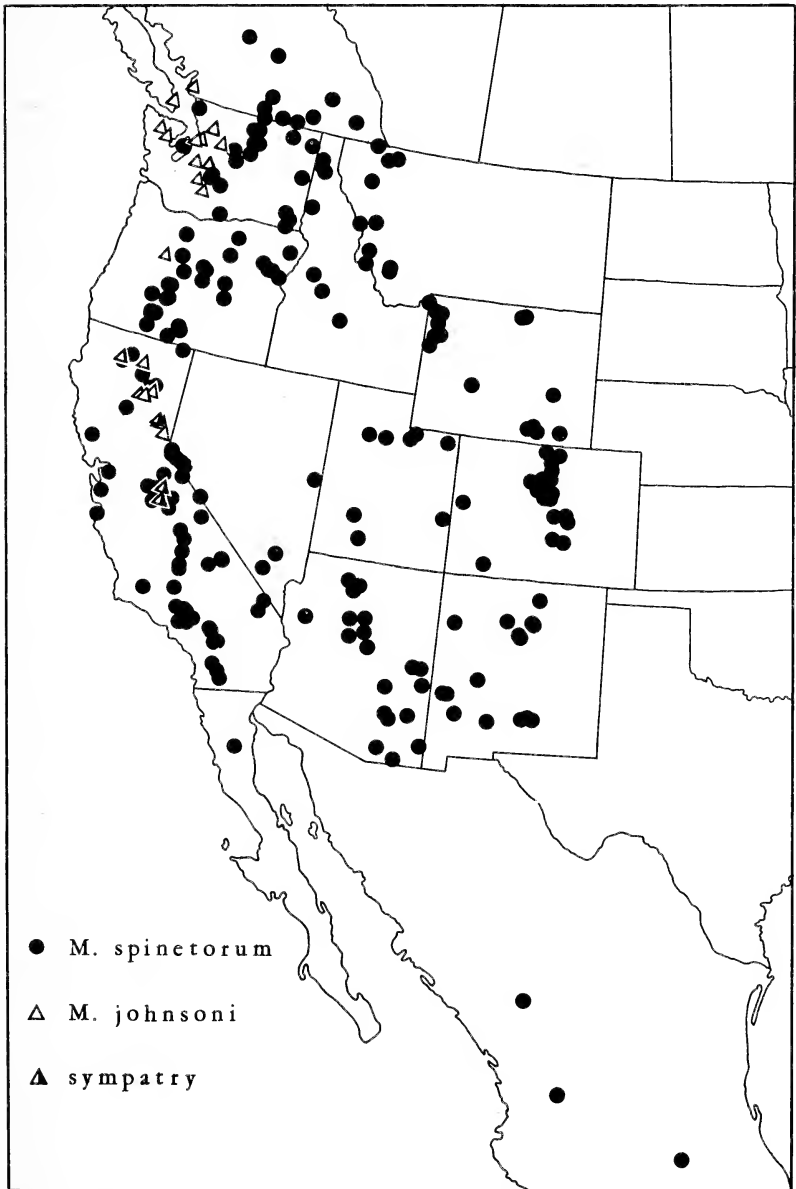


Fig. 3. Map showing distribution of *Mitoura spinetorum*, *M. johnsoni* and zones of sympatry.

Brower, G. W. Byers, F. H. Chermock, A. I. Good, C. V. Covell, C. F. dos Passos, H. A. Freeman, J. H. Masters, and J. B. Ziegler. I am indebted to F. M. Brown and P. McHenry for information on history, and to E. Norland for some flower determinations. Specimens were loaned or records were obtained from the following museums through the kindness of their curators:

(AMNH) American Museum of Natural History. F. H. Rindge. (BMNH) British Museum (Natural History). G. E. Tite. (CAS) California Academy of Sciences. C. D. MacNeill. (CIS) California Insect Survey, University of California at Berkeley. R. L. Langston, J. A. Powell. (CNM) Canadian National Museum. T. N. Freeman. (CM) Carnegie Museum. H. K. Clench. (CNHM) Chicago Natural History Museum. A. K. Wyatt. (CU) Cornell University. J. G. Franclemont, R. Poole. (LACM) Los Angeles County Museum. L. M. Martin. (MCZ) Museum of Comparative Zoology of Harvard University. W. T. M. Forbes. (NSM) Nevada State Museum. P. Herlan. (PM) Peabody Museum of Yale University. C. L. Remington. (SDNH) San Diego Natural History Museum. C. F. Harbison. (USNM) United States National Museum. W. D. Field. (UBC) University of British Columbia. G. G. E. Scudder. (UC) University of Colorado Museum. C. J. McCoy, Jr.; U. Lanham.

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APPENDIX

LOCALITY DATA

C. (M). SPINETORUM

(* = adults not reared)

CANADA.

BRITISH COLUMBIA. Cranbrook, VI-27-2, 1♀ (AMNH). Fairview, 2 mi. SW Oliver, VI-12-19, 2♀ (W. B. Anderson, USNM and UBC). Fife, nr. Christina Lake, VIII-4-59, *4 larvae (J. Grant). Jewel Lake, nr. Greenwood, VI-25-58, *3 larvae (J. Grant). Kaslo, ?-?-02 (J. W. Cottle, CNM). Keremeos, V-27-34; V-12-36 (both A. N. Gartrell, CNM). Keremeos Crk., V-25-2, 1♂ (UBC). Osoyoos, V-21 to 24-? (J. K. Jacob, CNM). Penticton, VI-15-18, 1♀; VI-7-19, 1♂ 1♀; V-24-21 (all W. B. Anderson, CNM, UBC, USNM). Robson, IV-19-39, 1; V-26-46, 2; V-14-49, 1 (all H. R. Foxlee). Shingle Crk. Rd., Keremeos, V-19 to VI-19-33, "series" (A. N. Gartrell, CNM). Squalix, VIII-13-46, 1 larva (S. H. Farris). Summerland, Garnett Valley, V-28-? (CNM). Young Lake, nr. Clinton, VII-20-56, 1 larva (W. E. Bitz). Locality undetermined: Vasseau, VII-14-20 (W. B. Anderson, CNM).

Kaslo Cr., 1♀ (USNM)

MEXICO.

BAJA CALIFORNIA. On trail into La Encantada, Sierra San Pedro Martir, 7000', V-30-58, 1♀ (J. A. Powell, in Patterson and Powell, 1959). DURANGO. Palos Colorados, 8000', VIII-6-47, 1♂ (C. D. Michener, AMNH). JALISCO. Bolaños, 1♀ (Richardson, BMNH, in Godman and Salvin, 1901). MEXICO. 6 mi. E Mexico-Michoacan boundary on highway 45, III-25-63, *1 larva (F. G. Hawksworth, D. Wiens, PM).

UNITED STATES OF AMERICA.

ARIZONA. Apache County: N. Fork of White River, 5 mi. SE McNary, VI-25-60 (K. Roever). N. Fork of White River, 7 mi. S McNary, VI-25-60, 1♂ (K. Roever); VII-4-59, 1♂ (W. Patterson). Greer, White Mtns., VI-17-54, 1♂ (C. W. Kirkwood, LACM). Horseshoe Cienega, 12 mi. E McNary, VI-26-60 (K. Roever). McNary, VI-21-42, 1♂ (E. R. Hulbirt). 2 mi. S McNary, VI-6-60 (K. Roever). Trout Crk. Rd., 12 mi. SE McNary, VII-4-59 (K. Roever). Trout Crk. Rd., 7 mi. S Smith Park, VI-25-60, 1♂ (K. Roever). White River nr. McNary, VIII-5-48, 1♀ (D. L. Bauer). Cochise County: Chiricahua Mtns., VI-8 to 15-?, 3♀; VI-16 to 23-?, 2♂ 2♀; VI-24 to 30-?, 1♂ 1♀; VII-1 to 7-?, 1♀ (all in USNM); VI-17 to 18-16, 1♂ 5♀ (V. W. Owen, LACM, in Comstock, 1927); V-23-34, 1♂ (J. A. Comstock, LACM); V-24-34, 1♂ (G. H. and J. L. Sperry, AMNH). Huachuca Mtns., V-?-?, 2♂ 1♀; VII-?-?, 1♂ (both USNM). Morris Canyon, Chiricahua Mtns., 5400', VI-12-06, 2♀ (V. W. Owen, LACM). Onion Saddle, Chiricahua Mtns., IX-2-51, 1♂ (C. D. MacNeill, CIS). Ramsey Canyon, Huachuca Mtns., VI-10-37, 2♂ 2♀ (J. L. Creelman, SDNH); 1♀ (J. L. Creelman); 1♂ (AMNH). 1 mi. W Reef, Huachuca Mtns., VII-5-62, "larvae" (F. G. Hawksworth, P. C. Lightle). Nr. Rustler Park, Chiricahua Mtns., VI-5-55, 1 (J. C. Spencer). Rustler Park, Chiricahua Mtns., 8700', VI-14-58, 1♂; VI-17-58, 4 (both C. D. MacNeill, CAS). Rustler Park, Chiricahua Mtns., VI-21-32, 6♂ 2♀ (E. R. Hulbirt); VII-4-51, 1♀ (D. L. Bauer); V-8-53, 3 (V. Nabokov, CU); V-28-58 (W. J. Reintal); V-11-62, 1♂ (W. Gertsch, AMNH). Vicinity of Southwest Research Station, Chiricahua Mtns., IV-27-62, 1♂ (C. W. Kirkwood). E. Turkey Crk. Canyon, Chiricahua Mtns., 6400', IV-15-60, 1♂ (K. Roever, W. Patterson). Coconino County: Bill Williams Mtn., VIII-1-59, 1 (W. N. Burdick, UC). 6 mi. N Flagstaff, 7300', VI-27-62, 1♀ (F. T. Thorne). 10 mi. N Flagstaff on Ski Bowl Rd., VI-27-62, 1♂ (W. A. Hedges). Fort Valley Exp. For., ca. 9 mi. NW Flagstaff, ca. 7500', VII-15 to VIII-15, '56 and '57, ca. 24 larvae (F. G. Hawksworth, in Remington, 1958). Fremont Saddle Road, 6 mi. N Schultz Pass Road, San Francisco Peaks, "larvae" (F. G. Hawksworth, P. C. Lightle). Grand Canyon, V-27-33, 1♀ (D. K. Duncan, AMNH). Hermit Basin, S. Rim Grand Canyon, 5250', VI-4-42, 3♂ 1♀ (J. S. Garth, in Garth, 1950). Mather Point, S. Rim Grand Canyon, V-26-60, 1♂ (K. Roever). Neal Spring, N. Rim Grand Canyon, VI-14-56, 1 (V. Nabokov, CU). Oak Creek Canyon, VIII-12-45, 1♀ (D. L. Bauer); Lower part, VII-12-53, 1♀ (J. W. Tilden). Pima Point, Grand Canyon, V-25-60, 1♀ (K. Roever). Nr. Schultz Pass, San Francisco Pks., VI-6-51, 2♀ (D. L. Bauer). Schultz Pass, 8000', VI-7 to 8-59; V-27-60; VI-14-64 (all K. Roever). Schultz Pass, 7 road mi. NW Flagstaff, 7800', VI-12-63, 3♂ 6♀ (F. T. Thorne). Snow Bowl, San Francisco peaks, 9000', VI-23-62 (K. Roever). Swamp Ridge, N. Rim Grand Canyon, 7500-7750', VII-16-47, 1♂ (J. S. Garth, in Garth, 1950). Ca. 4 mi. S Williams, Kaibab Nat'l For., ca. 7000', VI-20-64, "1 larva (F. G. Hawksworth, in Remington, 1958). Yavapai Point, S. Rim Grand Canyon, 7000', VI-3-42, 1♂ (J. S. Garth); VII-12 to 18-44 (L. Schellbach, in Garth, 1950). Gila County: Pinal Mtns., IX-15-47, 1♂ 1♀ (D. L. Bauer). Pine, VII-10-58, "several" (J. W. Tilden). 7 mi. NE Strawberry, VI-12-60 (K. Roever). Graham County: Swift Trail, 1 mi. E Twilight Canyon, cal. 7000', VII-10-64, 1♀ (K. Roever). Greenlee County: Hannagan Meadows, Blue Range, VI-?-?, (R. H. T. Mattoni); VII-1-33, 1♀; VII-12-52, 1♂ (both E. R. Hulbirt). K. P. Cienega Forest Camp, Blue Range, 9300', VI-14-63, 1♀ (O. Shields). Rt. 666, 2 mi. S K. P. Cienega, VII-1-62 (K. Roever). Mohave County: 12 mi. S Kingman, Hualapai Mtns., 6000', VII-6-54, 4♀ (O. E. Sette). Pima County: Redington, 1♂ (USNM). Santa Catalina Mtns., V-10-03, 1 (Oslar, CM); V-25-37, 1♂ (O. Bryant, CAS). Pinal County: Peppersauce Canyon, V-18-33, 1♀ (G. H. and J. L. Sperry, AMNH). Santa Cruz County: Daly Mine Trail, Madera Canyon, Santa Rita Mtns., 6200', VII-13-60, 1♀ (K. Roever). Yavapai County: Jerome water tanks, IV-13-51, 2♀ (D. L. Bauer). 1/2 mi. S Musinus Mtn. Inn, VI-3-59 (K. Roever). County undetermined: Paradise Crk., White Mtns., 8500', VI-7-?, 1 (D. K. Duncan, CU). South Arizona, 2♀, 1♀ (Poling, BMNH and CAS). White Mtns., VI-9-?, 1 (CU); VI-19-?, 1 (CU); VI-7-33, 1♂ 3♀ (D. K. Duncan, AMNH); VI-6-34, 1♀ (D. K. Duncan); VI-18-35, 2♀; VI-19-36, 1♂ (both G. H. and J. L. Sperry, AMNH); VII-1-41, 1♂ (AMNH); VI-16-47, 1♂; VII-4-51, 2♂; VI-10-53, 1♂ (last 3 E. R. Hulbirt); 8900', VI-14-47, 1♂ 3♀ (D. B. Stallings, J. R. Turner).

Apache County: Alpine Divide, VI-27-65, 1♀ (J. Scott). Coconino County: Pinal Point, Grand Canyon, VI-24-65, "seen", J. Scott; 2 mi. SW Sunset Crater Nat. Mon. turn off, VI-25-65, 1♀ (J. Scott).

CALIFORNIA. Amador County: 1.4 mi. E Round Valley, W Silver Lake, highway 88, VI-28-60, 1 (N. La Due). Calaveras County: Camp Wolfeboro, N. Fork Stanislaus River, 5600', VII-?-53, 1♂ (P. Opler). Contra Costa County: Mt. Diablo, IV-2-49, 1♂ (R. P. Allen, CAS). Russellman Park, Mt. Diablo, V-16-59, 1 larva (E. S. Ross, in Tilden, 1960). Inyo County: Argus Mtns., IV-?-? (CM); IV-?-91, 3♂ (Koebele, CAS and USNM). Telescope Peak, VI-24 to 25-30, 1♀ (AMNH). Westgard Pass, VII-28-54, 1♀ (J. A. Powell, CIS). Wildrose Canyon, Panamint Mtns., VII-4-40, 1♂ + 1 (C. Henne). Kern County: Nr. Alta Sierra, 11 mi. W Kernville, VI-10-61, 1♀ (R. E. Stanford). Road to Double Mtn., 5000-

6000', VI-22-64, 1 (N. La Due). Frazier Park, 7 mi. W highway 99 (E. R. Hulbirt). W end Frazier Park, V-17-61, 1q (N. La Due). 2 mi. W Frazier Park, VII-12-57, 2s (P. Opler). Greenhorn Mtns., VI-28-30, 1s (J. S. Garth); VII-5-33, 1q (CIS); VII-1-40, 1q (L. M. Martin, LACM); VI-24-61, 1 (R. E. Stanford and K. Hughes). Greenhorn Mtns., 29 mi. NE Bakersfield, 5600', VI-12-57, 1q (O. E. Sette). 2.3 mi. S Greenhorn Summit Lodge, Greenhorn Mtns., VII-7-63, 1q (A. H. Rubbert). Havilah, Piute Mtns., VI-20-2, 1 (F. Grinnell, Jr., CM); VI-2-22, 1 (MCZ). Nr. Lebec, VII-13-51, 1s (E. R. Hulbirt). Shirley Meadows, Greenhorn Mtns., 8000', VII-4-36, 1q; VI-27-37, 1q (both C. Henne). Tehachapi Mtns., 8000', VII-19-36, 2q + 1 larva (C. Henne, in Comstock and Dammers, 1938, not Greenhorn Mtns.). Ca. 3 mi. W Tehachapi, IX-17-60, "numerous" (J. W. Tilden). Tehachapi Mtn. Park, 6000', VII-14-59, 1q (F. T. Thorne). Tehachapi Mtn. Park entrance, 8 mi. SW Tehachapi, 5600', VI-30-63, 1q (E. M. Perkins). Lake County: Boggs Mtn. For. Sta., Cobb, 1 larva (F. Cobb, Jr., CIS). Lassen County: Black's Mtn., VI-13-41, 1q (P. D. Hurd, AMNH). Los Angeles County: Nr. Acton, V-17-25, 1q (J. D. Gunder, in Gunder, 1930). Crystal Lake Recreation Area, VII-27-53, 1s (J. S. Garth). 1.2 mi. S Little Rock Dam, ca. 3500', III-11-61, 1s (A. H. Rubbert). Pasadena, VII-20-2, 1 (CM). Ridge Route, VI-2-2, 1s (J. A. Comstock, in Gunder, 1930). Sierra Madre Range, VII-5-20, 1s (in Wright, 1922, Comstock, 1927, Gunder, 1930; cuyamaca paratype no. 4). Madera County: Bass Lake, 3500', ca. VI-24-59, 1 (E. Pfeiler). Mariposa County: Meadow nr. Bridleveil Crk. Campground, Yosemite National Park, VI-20 to 24-61, "several" (T. P. Webster). Ca. 1 1/2 mi. ESE Crane Flat Ranger Sta., Yosemite Nat'l Park, 6100', VII-25-64, 1 larva (O. Shields). Jerseydale, 8.5 air mi. NE Mariposa, 3800', VI-18-57, 1q; VII-27-62, 1s 1q; VII-29-62, 1q; VIII-3-62, 1s; VII-25-63, 1s; VIII-2-63, 1q; VIII-4-63, 1q (all O. Shields). 2 mi. W Mariposa, ca. 1800', 2s (J. Roberts). On talus slope overlooking Mirror Lake, Yosemite Valley, 5000', VII-7-63, 1q (J. C. Montgomery). Tioga Road near Tamarack Flat, 7 mi. W Yosemite Valley, 7200', VII-8-53, 1s (A. H. Moeck). Yosemite Valley, VII-1-19, 1s (AMNH). Modoc County: Willow Ranch, VII-2-26, 1q (G. Heid, CAS). Mono County: Spring Canyon, 3 mi. NE Walker, VI-24-62, 1q + 4 (J. A. Powell, C. D. MacNeill, CIS and CAS). Monterey County: Nr. entrance of Del Monte Lodge, Monterey Peninsula, VIII-2-54, "saw 1" (J. C. Spencer). Riverside County: Upper Chino Canyon, III-2-2, "seen" (T. W. Hower). Idyllwild, VII-2-26, 1s; VII-10-27, 1s (both J. S. Garth). Middle Drive, Idyllwild, San Jacinto Mtns., 5500', IX-6-64, 1s (J. F. Emmel). Desert side San Jacinto Mtn., "specimens" (Herr, in Grinnell and Grinnell, 1907). On trail to Mt. Taquitz, Idyllwild, 6500', IX-1-57, 2s 1q (J. C. Montgomery). San Bernardino County: Mt. Baldy Road, above Baldy Village, 5000', VI-17-61, 1s (D. Beals). Big Bear Lake, SE side, VI-17-34, 1s (E. R. Hulbirt). Bonanza King Mine, Providence Mtns., III-31 to IV-8-34, 1q (AMNH); IV-12-47, 2q (E. R. Hulbirt); IV-10-60, 1s (P. Opler); 3700', IV-22-38, 1q (C. Henne). Nr. Camp Radford, VII-6-63, 1q (R. E. Stanford). Mitchell Caverns State Park, Providence Mtns., IV-10-60, 1s (P. Opler). Canyon NNW Mitchell Caverns S. P., Providence Mtns., ca. 4200-5000', IV-13-63, 1s 1q (C. Henne, O. Shields); ca. 5000', IV-11-64, 1s 2q (S. K. Dvorak, O. Shields). 6 air mi. S Ivanpah, New York Mtns., IV-16-64, 1s 2q (R. L. Langston). Lytle Creek, NW San Bernardino, early-VII-36, 1q (T. W. Hower, in Comstock and Dammers, 1938). Providence Mtns., V-5-34, 1s (G. H. and J. L. Sperry, AMNH). Atop peak in Providence Mtns., III-25 or 26-63, 2s (J. F. Emmel). Rim of the World Highway, nr. Lake Arrowhead turnoff, 5000', VII-28-37, 7 larvae (C. Henne, in Comstock and Dammers, 1938). Nr. mouth S. Fork Santa Ana River, 6200', VII-2-06, 1s; 6400', VII-20-06, 1q (both J. and F. Grinnell, in Grinnell and Grinnell, 1907). Along Santa Ana River, 1 mi. W of E end Barton Flats, 5500', VIII-12-63, 1q (T. C. Emmel). Santa Ana River, N Barton Flats, ca. 5500', VI-29 to VII-1-64, 2s 6q; VII-11-64, 1s (both S. K. Dvorak). Stocton Flats, 6000', VI-28-30, 1q; VI-14-36, 1q (both T. W. Hower). 3-4 mi. SE Wrightwood, San Gabriel Mtns., 4500', VI-21-64, 1 (R. Meyer). San Diego County: Boiling Springs and/or Horse Heaven Canyon, ca. 2 mi. NW Mt. Laguna, Laguna Mtns., ca. 5500-5700', IV-29-34, 3; V-24-36, 7q; VI-26-42, 1s; V-21-44, 2 (all F. T. Thorne); IV-28-46, 1q 10q + 12 (J. L. Creelman, SDNM); V-2-46, 4s 5q; V-4-46, 1s 1q + 3 (F. T. Thorne); IV-25-48, ca. 60; V-16-48, ca. 60, mostly s (all J. L. Creelman); V-27-51, "saw 1" (F. T. Thorne); VII-15-51, 1s 2q (R. L. Langston, F. T. Thorne); VII-22-56, 2s 1q; V-5-57, 1 (all F. T. Thorne); V-5-57, 1s (A. H. Rubbert); V-25-58, 3; VIII-9-58, 3 (all F. T. Thorne); IV-9-60, 1q (R. W. Breedlove); IV-16-60, 2s 1q (R. W. Breedlove, W. A. Hedges, F. T. Thorne); VIII-6-60, 3s; IV-9-61, 3s 15q; IV-15-61, 2s 6q; V-20-61, 1q; V-29 to 30-61, 2s 2q (all R. W. Breedlove); VI-14-61, 1q (F. T. Thorne); VI-17-61, 1q (R. W. Breedlove); VI-24-61, 2s 6q + 1 (W. A. Hedges, F. T. Thorne); IV-21 to 24-62, 20s 24q + 3 (R. W. Breedlove, W. A. Hedges, F. T. Thorne, 6 in SDNM); IV-27-62, 10q + 12 (S. K. Dvorak, W. A. Hedges); V-6-62, 10q; V-25-62, 3q (all O. Shields); VI-5-62, 7q; VI-6-62, 1q 11q (both S. K. Dvorak); VI-7-62, 3q (O. Shields); VI-9-62, 1q (F. T. Thorne); VI-16-62, 13q (S. K. Dvorak); VII-17-62, 1q (F. T. Thorne); VIII-18-62, 1s (R. W. Breedlove); IV-13-63, 2s 14q (R. W. Breedlove, S. K. Dvorak, W. A. Hedges); V-12-63, 1q 4q (O. Shields); V-19-63, 1s 2q (R. W. Breedlove); VI-2-63, 9s 2q; VI-9-63, 1s 7q; VI-15-63, 5s 17q; VI-29-63, 3s 14q; VI-30-63, 19q; VII-4-63, 2s 7q (all S. K. Dvorak); VII-17-63, 1s 3q + 1 larva

(F. T. Thorne); VII-4-63, 1♂ 8♀; VIII-9-63, 5♀; VIII-17-63, 1♂ 5♀; VIII-24-63, 7♀ (all S. K. Dvorak); V-16-64, 1♂; V-22-64, 1♂ 4♀ (both O. Shields); V-23-64, 2♂ 9♀ (K. Roever, O. Shields, F. T. Thorne); V-31-64, 2♀ (S. K. Dvorak); VI-6-64, 3♂ 2♀ + 1 (S. K. Dvorak, O. Shields); VI-15-64, 2♂ 2♀; VI-21-64, 1♂; VII-16-64, 3♂ 1♀; VII-29-64, 1♀ (all S. K. Dvorak); IV-28-64, 2♀ (F. T. Thorne); V-1-64, 5♀ (O. Shields); V-9-64, 3♂ 9♀ (O. Shields); V-16-65, 2♂ 7♀ (F. T. Thorne); V-20-65, 10♂ 11♀ (F. T. Thorne); V-27-65, 4♂ (R. W. Breedlove). Carrizo Creek, 4 mi. SE Henshaw Dam, VII-20-64, 3♂; VIII-28-64, 2♀ (both S. K. Dvorak). Cuyamaca, Laguna Mtns., VII-21-25, 1♂; VII-27-26, 1♂ 1♀ (CIS). W below Cuyamaca Dam, VI-23-62, 2♀ (S. K. Dvorak). Cuyamaca Lake, VII-7-18, 1♂ (SDNH, cuyamaca allotype, in W. S. Wright, 1922). W below Henshaw Dam, ca. 2700', VI-29-63, 1♂ 11♀; VII-4-63, 4♀; VII-8-63, 12♀; VII-20-63, 5♀; VII-27-63, 13♀ (all S. K. Dvorak). Julian, VIII-4-17, 3♂ 1♀ (cuyamaca holotype ♀ and paratypes 1-3 ♂♂, in Wright, 1922); VII-4-18, 1♀ (USNM, paratype in Wright, 1922). Laguna Mtns., VI-30-20, 1♂; VII-21-23, 1♂ 5♀ (both W. S. Wright, LACM); VII-27-24, 1♂ 1♀ (W. S. Wright, SDNH); VII-20-24, 1♀; VII-27-24, 1♂; VII-28-24, 13♂ 4♀; VII-29-24, 1♂ 1♀; VII-30-24, 5♂; VIII-1-24, 2♀; VIII-7-24, 2♂; VIII-8-24, 1♀ (all AMNH); VII-10-25, 1♂; VII-19-25, 2♂ 1♀ (both CAS); VII-14-26, 1♀ (SDNH); '9.31.26', 1♂ 4♀ (G. Field, SDNH and CNHM); V-6-28, 1♀; VI-28-33, 1♀; VII-27-33, 1♂ (C. M. Brown, AMNH); VII-28-34; VI-18-38, 1♂ (C. M. Dammers, LACM); V-5-46, 1♀ (J. L. Creelman, SDNH); VI-25-53, 1♂ (J. A. Powell, CIS); ca. 6000', V-29-64, 1♂ 3♀ (F. T. Thorne). Mt. Laguna, Laguna Mtns., VII-28-33, 1♀ (AMNH); VII-28-35, 1♀ (C. M. Brown); 6000' (CM). Ca. 3 mi. N Palomar P. O., Palomar Mtns., VI-27-64, 3♂ 2♀ (S. K. Dvorak). Pine Valley, V-16-48, 1♂ (J. L. Creelman, SDNH). 4 mi. NE Pine Valley, Laguna Mtns., VI-11-60, 2♂; V-21-61, 1♂ (both O. Shields). Santa Ysabel Creek, Volcan Mtn., VI-15-63, 3♀ (S. K. Dvorak). Warner Hot Springs Mtn., 6000', VII-16-52, 1♂ larva (A. Forbes). 3 mi. E Wynola, Volcan Mtn., VII-29-57, 1♀ (F. T. Thorne). Santa Clara County: Saratoga, VII-?-43, "some" (T. B. Blevins). Shasta County: Castella, VI-?-03, 1♀ (F. X. Williams, CAS). Lake Britton, VII-16-54, 1♂ (C. D. MacNeill, CIS). Sierra County: Gold Lake Lodge, 6560', VII-1-61, 2♂ (P. Opler, in Opler, 1962). Siskiyou County: Mt. Shasta district, 1 (MCZ); 1♀ (H. Edwards, AMNH). Timberline, Mt. Shasta, VII-20-36, 1♂ (E. C. Johnston, AMNH). Tehama County: Inskip Mtn., Highway 32, ca. 2500', IV-16-60, 1♂ (S. O. Matton). Tehama-Butte County line: Mouth of Pine Creek Canyon, 15 mi. SE Vina, ca. 500', III-19-60, 1♂ (S. O. Matton). Tulare County: Big Meadow, Sequoia Nat'l For., VI-26-61, 1 (T. P. Webster). Mineral King, VI-24-30, 1♂ (USNM); 8000', VI-20-61, 1 (E. Pfeiler). Quaking Aspen Meadows, nr. Camp Nelson, 4500', VII-4-37, 1♂ (C. Henne). Smokey Valley, XYZ Creek, 6000', V-18 to 20-53, 1♂ 2♀ (C. Henne, C. H. Ingham). Tuolumne County: Rd. to Aspen Valley, 1 mi. S to 3 mi. SW Ackerson Meadow, 5100', VIII-2-64, 2 larvae; 5300', VIII-2-64, 6 larvae; 5400', VIII-2-64 8 larv.; 5900' (all O. Shields). Crane Flat Ranger Sta., Yosemite Nat'l Park, 6200', VIII-28-64, 1 larva (O. Shields). Dodge Ridge, VII-20-51, 1♀ (C. D. MacNeill, CIS). Groveland Ranger Sta., 7 air mi. ESE Groveland, 3300', VII-23-64, 1 larva (O. Shields). Hog Ranch, 1 mi. E Mather, 4600', VII-3-64, 1♀ (O. Shields). Nr. Jacksonville, VII-12-61, 1♀ (J. A. Powell, CIS). Pinecrest, nr. U. C. summer camp, VI-25 to 26-52, 2♂ (W. Patterson). Rush Crk. Campground, 5.5 air mi. SSW Mather, 4600', VII-23-64, 1 larva (O. Shields). Tamarack Flat, Yosemite N. P., VII-4-54, 1♀ (J. W. Tilden). Tioga Road, VI-24-59 (J. S. Garth, in Garth and Tilden, 1963). Tuolumne Grove Big Trees, Yosemite N. P., 5900', VII-28-64, 4 larvae (O. Shields). Ventura County: Quatal Canyon, NW corner Ventura Co., 5000', IX-12-64, 1♂ (J. A. Powell, CIS). County undetermined: Bramley, VII-2-26, 1♂ (AMNH). Lassen National Park, VII-21-37, 1♀ (J. A. Comstock, LACM). Mountains of California, 1♂ (Morrison, BMNH). Panamint Mtns., IV-?-91, 1♀ (USNM). Yosemite. VI-21-34. 1♀ (T. Craig. CAS).

Amador County: Jackson Rd., IX-2-63, 2 lar. (J. Hamail). Sierra County: Gold Lake Lodge, 6560', VII-19-65, 1♀ (O. Shields).

COLORADO. Boulder County: Highway 119, 3 mi. W Boulder, VI-3-60, 1♂ 3♀ (R. J. Jae). Boulder Canyon, V-16-64, 1♂ 1♀ (D. Eff). Road to Brainard Lake, above Ward, 9500', VI-11-54 (R. Leuschner); 9600', VI-12-54, 4♀ (D. Eff. in Brown, 1955). Cardinal Hill, ca. 3 mi. SW Nederland, ca. 8800', VI-13-53, 1♂ 1♀; VI-13-54, 1♂ 1♀; VII-1-57, 1♂ 1♀; VI-28-60, 1♀ (all D. Eff. in Brown, 1955). Eldora, VII-11-47, 1♀ (P. S. Remington). Eldora and Nederland, ca. 10,000', VI-29 to VII-14-37, 1♂ 7♀ (C. L. and P. S. Remington, in Brown, 1955). Elk Park, VII-13-40 (Rodeck, in Brown, 1955). Flagstaff Mtn., VI-18-53, 2♀ (D. Eff. in Brown, 1955); VI-23-53, 1♀; VI-15-58, 1♂ 1♀; VI-28 to VII-1-59, 1♂ 4♀; VI-21-60, 1♀; V-28-63, 2♀; VI-13-63, 1♂ 1♀ (all D. Eff). Four Mile Canyon, V-8-48 (D. Eff. in Brown, 1955); V-16 to 19-58, 1♂ 1♀. Four Mile Creek Canyon, nr. Crismon, V-18-54, 1♀; V-24-58, 1♂ 1♀ (all D. Eff). Ca. 2 mi. W Gold Hill, VI-12-59, 1♀ (D. Eff). Lefthand Canyon, VI-12-54 (D. Eff. in Brown, 1955); V-23-58, 1♀ (D. Eff); V-23-62, 1 (J. Scott). Lickskill Gulch, N Gold Hill, 7800', V-18-54, 1♀ (D. Eff. in Brown, 1955). Magnolia Road, V-30-54, 1♀ (D. Eff. in Brown, 1955); VI-2-60, 1♂ (D. Eff). Mt. Meeker Camp Grounds, Thompson Canyon, 7500', VI-30-53, 2♂ 3♀ (A. H. Moeck, in Brown, 1955). Millionaire Gulch, nr. Sugarloaf, ca.

- 7000', V-15-52, 1q (D. Eff, in Brown, 1955). Nederland, 8100', VII-9-49, 1q (C. L. Remington, PM). Nr. Nederland, 8369', VIII-2-57, 3σ (R. J. Jae). Soda Spring gulch, S Crismon, ca. 6261', VI-7 to 8-53, 3σ 3q (D. Eff, in Brown, 1955); V-16-58, 3σ 3q; V-19-58, 1σ 4q; V-17-60, 1q (all D. Eff). Sugarloaf, VI-2-57, 1q; V-19-58, 2σ 2q (all D. Eff). Nr. Sugarloaf, V-30-58, q (all D. Eff). Above Sunset, ca. 8400', VI-12-59, 1σ (D. Eff). Sunshine Canyon, V-30-62, 1 (J. Scott). Tennessee Park, S Nederland, VI-5-59, 1q (D. Eff). Clear Creek County: Highway 68, VI-20-54, 1σ 2q (R. J. Jae). Placer Valley, 7500', VI-23-53 (H. Epstein, in Brown, 1955). Squaw Mountain Meadow, 11,000', VII-3-64, 11σ 6q, "numerous" (R. J. and D. A. Jae). Costilla County: Valles Crk., VI-27-44 (B. Rotger, in Brown, 1955). Custer County: San Isabel Nat'l For., Wet Mtns., highway 96, ca. 7800', VI-16-59, 1q (W. H. Howe). El Paso County: Rock Crk., 8500', VI-18-53 (F. M. Brown and H. Epstein, in Brown, 1955). Star Ranch, 6 mi. S Colorado Springs, on highway 115, 6700-6800', V-19-62, 4σ; VI-11-62, 1q; VI-14-62, 1q; VI-29-62, 1q; V-4-65, 1; V-12-65, 3 (all S. A. Johnson). USAF Academy, 8000', VI-3 to 4-62, 3; mid-to late-V-63, 4 (all J. A. Justice). Gilpin County: Lump Gulch, VII-27-57, 1 (H. G. Rodeck, UC). Rollinsville, VI-24-53 (H. Epstein, in Brown, 1955); VI-8-58, 2σ 2q (R. J. Jae); VI-16-58, 8σ 18q; VI-18-58, 1σ 1q (all R. J. Jae); VI-14-60, 1q (J. Hazlett); VI-23-64, 1σ 32q (J. A. Justice). Nr. Rollinsville, VI-14-60, 8σ 31q (R. J. Jae). Summer Home Group, Rollinsville, highway 119, 8380', VII-3-55, 2σ; VII-21-54, 1σ 1q (all R. J. Jae). Tolland, VI-28-47, 1; 8900', VI-29-49, 3σ 4q (all D. Eff). Grand County: Fraser, VII-2-54, 1σ 1q; VII-3-54, 1σ; VII-4-54, 1q (all J. J. Renk). Grand Lake, VII-4-35, 1q (E. R. Hulbirt); VII-1-49, 8 (V. Nabokov, CU). Hideaway Park, VII-4-60, 12 (Noel La Due); 8715', VI-23-54, 1σ (L. M. Martin); ca. 8900', V-?-?, "swarming" (W. Tyeryar); VI-23-54, 2σ 3q (D. Eff, in Brown, 1955); 9000', VI-27-62, 2q (S. Ellis, S. A. Johnson); VII-5-64, 3σ (R. J. Jae). Hideaway Park, Idlewild, VIII-4-64, 1σ (J. A. Justice). Maryvale, nr. Fraser, VI-25-54 (J. J. Renk, in Brown, 1955); VI-28-55, 2σ (J. J. Renk). Maryvale, Middle Park, 9000', VI-27-60, 14σ 9q (R. J. and B. R. Jae). Middle Park, 9000', VII-1-60, 2σ 1q (R. J. Jae). 1 mi. W Tabernash, 9000', VI-27-62, 1σ (S. Ellis). Gunnison County: Coal Crk., VI-6-64, "saw 1" (S. Ellis). Snowshoe Creek, 3 mi. SE Paonia Dam, 7720', VI-14-63, 1σ (S. Ellis). Jefferson County: Conifer, VI-7-02, 1σ 1q (A. J. Snyder, CNHM). The Teepees, VI-23-64, 1q (R. J. Jae). La Plata County: Durango, V-?-99 (Oslar). Larimer County: Between Columbine Lodge and Lily Lake, Estes Park, 9500', "Last week of V-47", 20 (V. and D. Nabokov, MCZ and CU). La Porte, VII-13-34, 1σ (K. Maehler). Long's Peak, 9000-9500', VI-25-53 (H. Epstein, in Brown, 1955). Ca. 8 mi. W Redfeather Lakes, ca. 9300', "larvae" (T. E. Hinds, USNM, in Remington, 1958). Trail Ridge, Rocky Mountain N. P., VII-9-33, 1q (G. H. and J. L. Sperry, AMNH). Mesa County: W end Black Ridge, nr. Colorado National Monument, ca. 7000', VII-23-64, 1σ (T. C. Emmel). Park County: Bailey, VI-23-63, 1σ (J. Scott). Hall Valley, 9600', VI-28-53, 1 (F. M. Brown, UC, in Brown, 1955). 4 mi. E Kenosha Pass, VI-17-71 (Mead, in Brown, 1955, minus TL). Pueblo County: Beulah, VI-16-42, 2σ 4q (D. B. Stallings and J. R. Turner, in Brown, 1955). Summit County: Dillon, VI-27-53 (H. Epstein, in Brown, 1957). Gore Range Trail, nr. Cataract Creek, 9000', VI-17-64, 1σ (J. A. Justice). Snake River, VI-22-53 (H. Epstein, in Brown, 1955). Teller County: Big Spring Ranch, nr. Florissant, 8640', VI-19-60, 1q; VI-25-60, 1q + 1 (All T. C. Emmel). Pike National Forest, 7750', V-12-63, 2σ. County undetermined: 1σ (Belt, BMNH). Battle Mtn., Rocky Mountain National Park, VI-21-53, 1q. "Denver" (CM). Rocky Mountain N. P., VI-22-53, 1σ (L. M. Martin, LACM); 10,000', VII-9-59 (E. J. Dornfeld). Above Sprague's Lodge, 8800', Rocky Mtn., N. P., VI-23-53, 1σ (P. C. Ritterbush, PM). Sprague's Lodge, 8700', Rocky Mtn. N. P., VI-25-54, 1q (P. C. Ritterbush, PM). Boulder County: Baird Park, Gregory Cn., IV-21-65, 1σ (J. Scott); Four Mile Cn., V-29-65, 12σ 5q (J. Scott); Sugarloaf Mtn., V-29-65, 3σ 9q. Mesa County: Black Ridge, 7000', V-30-65, 1σ (S. Ellis). IDAHO. Blaine County: Ketchum, VII-20-54, 1σ (E. R. Hulbirt). Bonner County: Priest River, 1q (USNM); V-24 to 25-10, 1σ 1q (C. W. Herr, LACM); VI-8-15, 1q (USNM). Butte County: Bear Pass Crk., VII-26-47, 1σ (R. M. Bohart, CIS). Kootenai County: NE end of Hayden Lake, VII-12-62, 2q (D. L. Bauer). Spirit Lake, VII-1 to 7-?, 1q (USNM). Latah County: Moscow Mtns., V-26-28, 2q (AMNH). Moscow Mtn., cal. 5000', VI-29-60, 1q + 1; cal. 3500', VII-1-64, 1σ + 1 (both R. E. Miller). Lemhi County: Gibbonsville, VII-1-58, 1q (D. L. Bauer). Valley County: Bear Valley, VII-2-58, 1q (D. L. Bauer). McCall, Payette Lakes, VII-20-44; VII-17-45 (both J. H. Baker). MONTANA. Beaverhead County: Elkhorn Hot Springs, VII-11-59, 3σ 4q + 3 (T. W. Davies). Polaris, VI-25 to 27-? (CM); VI-15-41, 1σ 1q; VI and VII-42, "series". Flathead County: Kintla Crk., Glacier Nat'l Park, VII-2-50, 1σ (J. S. Garth). Lake McDonald, Glacier N. P., VII-12-54, 1q (J. S. Garth). 1 mi. S Lakeside on highway 93, 2800', VII-1-61, 1q (E. M. Perkins). Gallatin County: Ousel Falls (CM). West Yellowstone, VI-21-62, 1 (J. Scott). Glacier County: Saint Marys, Glacier N. P., 4500', VII-22-35, 1σ (J. S. Garth). Saint Mary's Baring, Glacier N. P., VII-27-35, 1σ (J. S. Garth). Sunrift Gorge, Glacier N. P., VII-14-35, 1q (J. S. Garth). Granite County: VII-?-? (CM). Missoula County: Lee Crk. Camp, 1 mi. S Lolo Hot Springs, 4000', VIII-4-56, 1σ (F. and P. Rindge, AMNH). Patee

Canyon, VI-23-62, 1 (J. Scott). Powell County: Rock Crk. Lake, VII-2-59, 1♂ (T. W. Davies). Ravalli County: E. Fork Bitterroot River, 2 mi. N Sula, ca. 3000', VII-20-64, 1♂ (J. H. Shepard). Warm Springs Campground, VII-7-62, 2 (J. Scott). County undetermined: Hillside above Anaconda Crk., Glacier N. P., VI-28-50, 1♀ (J. S. Garth). Martina, 1♀ (USNM, in Wright, 1922).

NEVADA. Clark County: Charleston Mtns., VI-29-35, 1♀ (J. L. Bauer, LACM). Mt. Charleston, VI-15-40, 1♀ (L. I. Hewes, CAS). Mt. Charleston area, VIII-6-61, 1 (R. Stanford). Hidden Forest, Sheep Range, cal. 7000', VI-23-61, 1 (K. Roever). Lee Canyon, Spring Mtns., ca. 6000', VI-23-61 (K. Roever). Douglas County: E side Daggett Pass, IX-1-63, 1♀ (D. L. Bauer). Ca. 6-10 mi. SE Gardnerville, highway 395, 5900', VII-20-64, 1 larva (O. Shields). Haines Canyon, V-II-64, 1♂ (D. L. Bauer). Kingsbury Grade, State Highway 19, 5400', VII-19-64, 6 larvae (O. Shields); 5700', VIII-10-62, 1♀; VIII-12-62, 3♀; VIII-13-62, 1♂; VIII-15-62, 2♂ 1♀; VI-13-63, 1♂ 1♀ (all P. Herlan, NSM); VII-17-64, 2♀ (J. C. Downey); VII-18-64, 8 larvae (J. F. and T. C. Emmel, J. C. Downey, O. Shields); VII-20-64, 2 larvae; 6400', VII-20-64, 1 larva (both O. Shields). Pine Nut Crk., 5500-6000', V-21-64, 1♀; VI-12-64, 1♂ 1♀ (both D. L. Bauer). Lyon County: O'Banion Canyon, 8 mi. S Wellington, 6000-7000', V-15-64, 4♂ (D. L. Bauer). Mineral County: Montgomery Pass, 7166', VI-26-53, 1 (D. Giuliani). Ormsby County: Nr. Sand Harbor State Park, Lake Tahoe, VI-9-41, 1♂ (D. L. Bauer). White Pine County: Lehman Crk., Mt. Wheeler, 7200', VI-3-64, 2♀ (K. B. Tidwell). Mt. Wheeler, V-30-29, 1♀ (F. W. Morand, AMNH). County undetermined: Gardner (CM).

Lake County: 5 mi. S, Crane Mtn., Mission Range, VII-10-64, 1♀ (C. L. and S. T. C. Remington); Porcupine Crk. Rd., S. Swan Lake, VII-7-64, 1♀ (C. L. Remington).

NEW MEXICO. Bernalillo County: N end Sandia Mtns., loop rd., VII-9-63, 1♀ (K. B. Tidwell). E slope Sandia Mtns., V-18-59, 1 (P. R. Ehrlich, CM). Catron County: 2-3 mi. E Mogollon, 7200-7600', VII-10-61, 1♂; VII-11-61, 3♂; VII-13-61, 1♀; VII-17-61, 1♂ 2♀ (all F., P. and J. Rindge, AMNH). Mogollon Range, V-7-40, 4♀ (UCM). Willow Crk. Ranger Station, 25 mi. E Alma, 8000', VII-15-61, 2♀ (F., P. and B. Rindge, AMNH). Dona Ana County: Rincon, VI-23-98, 1 (C. J. Paine, MCZ). Grant County: Gila Nat'l For., Pinos Altos Mtns., 7500', VII-26-52, 1♂ (A. H. Moeck). McMillan Camp, 13 mi. N Silver City, 6800', VII-24-61, 2♂ 3♀; VII-30-61, 1♀ (both F., P. and J. Rindge, AMNH). McKinley County: Fort Wingate, 1♂ 1♀ (AMNH); IV-16 to 23-2, 1♀; IV-24 to 30-2, 1♀; V-1 to 7-2, 1♀; V-16 to 23-2, 1♂; V-24 to 31-2, 1♂; VI-8 to 15-2, 1♂; VII-1 to 7-2, 1♀ (all USNM); V-17-06, 2♂ + 1 (CM and AMNH); VI-9-06, 1♀; "2, 28, 10", 1♀; V-6-10, 1♀; V-7-10, 1♀; V-10-10, 1♂; V-17-10, 2♂; V-19-10, 2♂ (all AMNH); VI-16-23 (CNM). Otero County: Alamogordo, V-2-02, 1 (CM). Cloudcroft, V-2-2 (A. W. Lindsey); 8400', VI-4-46, 2♂ 2♀ (D. B. Stallings, J. R. Turner). 2 mi. NE Cloudcroft, Sacramento Mtns., 8500', VI-4-61 (K. Roever). Mayhill, 8200', VI-4-46, 2♂ 1♀ (D. B. Stallings, J. R. Turner). Pine Forest Camp, 2 rd. mi. NE Cloudcroft, 8500', V-6-61, 1♂ 1♀ (K. Roever). Sandoval County: Jemez Springs, V-3 to 5-2, 2♂ 1♀; V-25-12; III-20-13; V-17-13; V-20-13; V-21-13 (all but 1st, CM, "series"); VII-2-29, 1♂ (AMNH); 7000', IV-9 to 23-2 (CM); VI-6-26, 1♂; VI-18-26, 1♂ 3♀; VII-2-26, 1♂; 8500', VI-20-26, 1♂ 2♀; 6600', VII-3-26, 1♂ (all AMNH). 3 mi. S Placitas, E slope Sandia Mtns., 6600', VII-15-64, 4 (M. Toliver); VII-25-64, 1♀ + 2 (R. Holland, M. Toliver); VIII-2-64, 1♀ + 1 (R. Holland). Socorro County: Bear Trap Camp, 28 mi. SW Magdalena, 8500', VII-19-64, 1; VII-22-64, 1 (both F., P. and M. Rindge, AMNH). Santa Fe County: Hyde State Park, 8 mi. NE Santa Fe, 8700', VII-29-64, 1 (F., P. and M. Rindge, AMNH). 2 mi. E Tesuque Pueblo, 7000', VIII-10-34, 1 (M. Hebard, CM). Taos County: Taos, 7500', VI-18-46, 3♂ 1♀ (D. B. Stallings, J. R. Turner). Vinatera Campground, Taos Canyon, 2 mi. E Taos, IV-21-62, 2 (J. Scott). County undetermined: Gila River, VII-6-90 (CM).

OREGON. Baker County: Anthony Lake, 6500', VII-12 to 13-51, 2 (R. Albright); 7100', VII-9-57 (J. W. Tilden). Baker, VII-4-41. Durkee, VI-10-40. Pine Creek, 11 mi. W Baker, 4000-5000', VI-17-31 (J. H. Baker); 4100', VII-7-57, 1♂ 1♀ (J. W. Tilden). Powell Creek, 2 mi. W Durkee, VII-18-? (J. H. Baker). Nr. Powder Lake, vicinity of Baker, VII-12-53, 1♂ (J. H. Baker). Powder Mtns., V-8-06, 1♂ (AMNH). Spring Creek, 3700', VI-21-55 (J. H. Baker). Clackamas County: Clackamas Lake, 4000', VII-3-61 (E. J. Newcomer). Crook County: S side of Big Summit Prairie, 4500-5000', VII-1 to 2-61 (E. J. Newcomer). Maury Mtns., 4500-5000', VII-1 to 2-61 (E. J. Newcomer). Ochoco Nat'l For., highway 26, 4000', VI-19-58 (E. J. Dornfeld). Ca. 16 mi. E Prineville, VI-7-58, 1♀ (S. G. Jewett, Jr.). Deschutes County: Nr. Bend, VI-20-39, 1♀ (CIS); VI-23-39, 1♀ (CIS). Along Little Deschutes River, nr. Odell Butte, ca. 4500', VI-2-57, 30 (R. Albright, H. Rice). Douglas County: Nr. Diamond Lake Lodge, VII-1-47, 1♀ (T. W. Davies). Grant County: Izee, 4046', V-23-34 (S. G. Jewett). Harney County: Cricket Creek, 13 mi. NW Burns, VII-11-63, 1♀; VII-21-63, 2♀ (both C. R. Crowe). Jefferson County: Metolius River area, 1 mi. WSW Camp Sherman, VI-14-64, 1♂ (C. W. Nelson). Klamath County: Annie Creek, S. boundary of Crater Lake National Park, VI-22 to 23-60, 2♂ (J. W. Tilden, D.

Huntzinger). Aspen Lake, VI-2-50, 1♀ (S. G. Jewett, Sr.). Beaver Marsh, VII-16-64, 1♀ (J. Scott). Bly Mtn., 5000', VI-22-59; VI-14-61; VII-7-62; VI-17-63 (all E. J. Dornfeld). Junction of Crescent Creek and State Hwy. 58, ca. 4000', VI-27-62, 1♂ (K. Goeden). Diamond Lake, 5000', VII-12-46, 1 (R. Albright); VI-21-62, 1♀ (C. A. Toschi, CIS). Fort Klamath, 1♀ (USNM). Gilchrist, 4500', V-27-58; VI-18-60; VII-10-60; VI-25-61; VII-8-62, "fairly numerous "; VI-18-63, 10 (all E. J. Dornfeld). Miller Crk., 4000', VI-30-62, 1♀ (E. J. Newcomer). Skookum Meadow, 5200', VII-23-61 (E. J. Newcomer). 5 mi. N Sun Pass, 4750', VII-10-62, 21 (D. J. Dornfeld). Lake County: Quartz Mtn., 5500', VI-12-62 (E. J. Newcomer). Morrow County: Willow Crk., nr. Heppner, 3500', V-4-62, 2♀; 3500-4000', V-16-62, 2♂ (both D. L. Bauer). Wallowa County: Chief Joseph Mtn., Joseph, VII-14-50, 1♀; VII-15-50, 1♀; VII-16-50, 1♂ 2♀ (all N. Crickmer, AMNH); VII-2-50, 1♂; VII-7-50, 1♂; VII-8-50, 1♂; VII-10-50, 1♀; VII-15-50, 3♀; VII-16-50, 1♀; VII-20-50, 1♀; VII-22-50, 1♀; VII-24 to 25-50, 1♂ 1♀ (all G. H. and J. L. Sperry, AMNH). Wallowa Lake, VI-14-39, 1♀ (CIS). Wheeler County: Fairview For. Camp, ca. 12 mi. N Spray, VI-7-62, 1♂ (D. L. Bauer).

UTAH. Beaver County: Beaver Canyon, VIII-2-2, 1♂ 1♀ (USNM). Garfield County: Bryce Canyon National Park, 8000', VII-8-61, 1♂ (K. B. Tidwell). Grand County: Warner Ranger Sta., La Sal Mtns., 9500', VII-21-36, 1♂. Summit County: E. Fork Bear River, Uinta Mtns., VII-3-64, 1♀; VII-4-64, 1♂; 8500', VII-17-62, 2♂ 3♀ (all K. B. Tidwell). N. Fork Provo River, Uinta Mtns., 7500', VI-7-61, 1♀; VII-14-61, 1♀ (both K. B. Tidwell). Tooele County: Loop Camp, Stansbury Mtns., 13 mi. SW Grantsville, 7400', VII-3-60, 1♀; VII-4-60, 1♀ (both F., P. and B. Rindge, AMNH). Lower Narrows Campground, Stansbury Mtns., VI-2-62 (K. B. Tidwell). South Willow Crk., Stansbury Mtns., VII-2-64, 1♀ (K. B. Tidwell). Uintah County: Kaler Hollow Camp, 22 mi. NNW Vernal, VII-24-63, 1♀ (F., P. and M. Rindge, AMNH). Utah County: Mt. Timpanogos, vicinity of ranger station, VII-12-47, 1♀ (E. R. Hulbert). Juab County: Mammoth, VI-17-65, 1 (J. Scott). Garfield County: Bull Cr., Henry Mtns., 5000', VI-16-65, 1♂ (S. Ellis).

WASHINGTON. Chelan County: Chelan (in Leighton, 1946). Coyote Crk., Lake Chelan (in Leighton, 1946). Mission Crk., nr. Cashmere, V-13-56, 2♀ (D. L. Bauer). Ca. 1, 5 mi. SE Plain, VIII-2-64, 9 larvae (D. V. McCorkle). 5 mi. S Plain, 2 larvae (D. Carney). Sand Crk., nr. Cashmere, V-29-57, 1♀ (D. L. Bauer). Second Crk. Canyon, nr. Plain, V-30-58, 2♀ (D. L. Bauer). Columbia County: Dayton, 3000', V-24-58, 1 (R. E. Miller). Table Rock, Blue Mtns., VII-20-35, 1 (J. F. G. Clark, CU). Tucannon River, Blue Mtns., VI-20-62, 1♂ 2♀ (R. E. Woodley); 3500', VI-17-61, 1♀ (E. J. Newcomer). Ferry County: Growden, Sherman Crk., Colville Nat'l For., VIII-30-63, *2 larvae; VII-24-64, *1 larva (both E. F. Wicker). King County: Beaver Lake (in Leighton, 1946). Kitsap County: Black Canyon, nr. Bremerton, V-4-47, 1♂. Klickitat County: Satus Pass, on old highway, 3149', V-25-63, 2♂ 1♀ (C. W. Nelson, S. F. Perkins). Satus Pass, 3000', VII-10-63, 1♀; VII-12-63, 1♀; 3700', VII-12-60; VII-3-62; VII-10-62 (all E. J. Newcomer). Nr. Satus Pass, 3000', V-18-63, 1♂ (E. J. Newcomer). Satus Pass Summit, VII-23-64, *1 larva (D. V. McCorkle). Along highway 97, just N Satus Pass summit, VI-25-61, 1♀ (R. E. Woodley). Okanogan County: Black Canyon, VI-9-62, 1♂ (R. E. Woodley). Boulder Crk. (in Leighton, 1946). Brewster, V-10-39, 1♂; V-11-47, 1♂; V-6-49, 2♂; V-7-49 (all J. C. Hopfinger). Salmon Meadows, 4400', VI-22-59 (E. J. Newcomer); ca. 4500', VII-10-64, 1♀ (R. E. Woodley). Oreille County: Ruby (in Leighton, 1946). Spokane County: 4 mi. N Spangle, U. S. Highway 195, VIII-31-63, *1 larva (E. F. Wicker). Yakima County: American River, V-24-58, 1♀ (J. H. Shepard). Bear Canyon, 25 rd. mi. NW Yakima, 3200', VII-2-60; VII-6-60; VI-22-62; VI-27-62, 1♂; VII-7-62 (all E. J. Newcomer). Chinook Pass Highway, 10 mi. E summit, VI-17-58, 1♀ (D. V. McCorkle). Mill Crk., 1100', VI-30-62, 1♀ (E. J. Newcomer). Oak Crk., off White Pass Highway, VI-13-60, 1♀; VI-16-60, 1♀ (both D. V. McCorkle). Oak Crk., 25 rd. mi. NW Yakima, 3500', VII-17-59; VI-24-60 (both E. J. Newcomer). Whatcom County: Bellingham, VI-30-17, 2 (J. F. Clarke, in Leighton, 1946). Okanogan County: Gold Crk., V-24-49.

WYOMING. Albany County: Albany, ca. 8500', VI-20-54; VII-4-55 (both G. R. DeFoliart, in DeFoliart, 1956). Centennial, 8500', VI-26-29, 1♀ (A. B. Klots, AMNH). Nash Fork Crk. at State Highway 130, Snowy Range, VII-14-64, 1 (V. Hardesty). Pole Mtn., 8500', VI-28-53; VII-11-53; VI-19-54 (all G. R. DeFoliart, in DeFoliart, 1956). Snowy Range Pass, E side Medicine Bow Mtns., 8000', VII-7-55, 2♂ 6♀ (A. H. Moock). Carbon County: Medicine Bow Lodge, VII-26-64, 1 (J. Scott). Converse County: Camel Crk. Campground, Medicine Bow Nat'l For., 8000', VII-19-64, 4♂ 4♀ (R. Hardesty, D. Groothuis); VII-23-64, 1♀ (R. Hardesty). Cold Springs, 7800', VII-2-64, 1♀ (R. Hardesty). Fremont County: Little Sheep Mtn., Wind River Range, 9000', VII-23 to 24-35, 3♂; VIII-9 to 12-35, 1♀ (both A. B. Klots). Louis Lake, 28 mi. SW Lander, 8600', VIII-2-62, 1♂ (F., P. and M. Rindge, AMNH). Sheridan County: 12-16 mi. SW Big Horn, 7700-8000', VII-19-59, 4♂ (F., P. and B. Rindge, AMNH). 13-15 mi. SW Big Horn, 7100-7900', VII-17-62, 3♂ 2♀ (F., P. and B. Rindge, AMNH). Long Park, 20 mi. SW Big Horn, 8100', VII-15-62, 3♂; VII-16-

62, 1♂ (both F., P. and M. Rindge, AMNH). Teton County: Nr. Colter Bay, Grand Teton National Park, VII-6-59, 1♀ (S. G. Jewett, Jr.). Grand Teton N. P., VI-20-30, 1♀ (E. C. VanDyke, CAS); VII-25-58, 1♀ (D. L. Bauer). 3.5 mi. N Grand Teton N. P., VII-6 to 7-59, 2♀ (S. G. Jewett, Jr.). Jackson Hole, VI-28-38, 1♀ (E. C. VanDyke, CAS). In Jackson Hole, along Yellowstone-Teton highway, VII-2-48, 1♀ (A. H. Moeck). Jenney Lake, Teton Mtns., VI-13 to 23-31, 2♀ (AMNH); VI-23-38, 1♀ (E. C. VanDyke, CAS); VII-16 to 17-59, 4♂ (T. W. Davies); 6800', VI-2 to 11-? (CM). Nr. Jenny Lake, VII-6 and 8-59, 1♂ 3♀ (S. G. Jewett, Jr.). Jenny Lake P. O., VI-26-58, 1♂ (J. S. Garth). Moran, VI-16-51, 1♀ (C. L. and J. E. Remington, PM). String Lake, Teton Range, VI-18-31, 1♀ (USNM). Taggart Lake trail, Grand Teton N. P., VI-18-62, 1 (J. Scott). Wilson, VIII-?-49, 1♂ (V. Nabokov, CU). Wilson Road, Grand Teton N. P., VI-26-58, 6♂ 3♀ (J. S. Garth). Yellowstone County: Upper Geyser, Yellowstone, "10.6.1888", 1♂ 2♀ (H. G. Elwes, BMNH). Yellowstone, 5♂ 5♀ ("F. D. G.", BMNH); 7000', VI-?-1887, 1 (H. J. Elwes, MCZ). Yellowstone National Park, 2♀ (AMNH); 1♀ (USNM); 1♂ (BMNH); (H. Y. Elwes, CNM); VI-22-41, 3♂ 1♀ (L. I. Hewes, pair in CAS); 6500', VII-7-38, 1♀. Yellowstone N. P., 44° 25' N, 110° 35' W, 7750', VII-20-20, 1♀ (AMNH).

C. (M.) JOHNSONI (= adults not reared)

CANADA.

BRITISH COLUMBIA. "Shawnigan", VI-17-25, 1♀ (E. H. Blackmore, USNM). Vancouver, VI-4-04 (R. V. Harvey, CNM); V-27-05, 1♂. North Vancouver, V-22-04, 1♀ (USNM).

UNITED STATES OF AMERICA.

CALIFORNIA. Lassen County: Silver Lake, VII-2-55, 1♀ (M. Doudoroff, in Dornfeld, 1959). Mariposa County: Jerseydale, 8.5 mi. NE Mariposa, 3800', VII-27-56, 1♂; VII-28-56, 1♀; VIII-9-56, 1♂; VII-27-62, 2♂; VII-28-62, 2♂; VII-22-63, 1♀; VII-23-63, 1♂; VII-24-63, 3♀; VII-25-63, 1♀; VII-26-63, 2♀; VIII-2-63, 1♀; VIII-3-63, 1♂; VIII-4-63, 1♂ 1♀; VIII-6-63, 2♀; VIII-19-63, 1♂; VII-25-64, 2♀ (all O. Shields). Placer County: Lower end of Sugar Bowl, Donner Pass, 15 mi. NW Lake Tahoe, VI-28-60, 1♀ (J. F. Emmel). Sierra County: 1.5 mi. E Bassett, 5460', VI-13-60, 1♂; VI-17-61, 2♀ (both P. Opler, in Opler, 1962). Gold Lake, VII-18-41, 6♂ 2♀ (AMNH). Gold Lake dam, VII-25-52, 1♀ (T. W. Hower). Gold Lake Lodge, 6560', VII-1 to 7-45, "30 or 40" (R. G. Wind); VII-1-61, 15♂ 1♀ (P. Opler, AMNH and PM, in Opler, 1962). Summit of Yuba Pass, 6708', VII-1-61, 1♂ 1♀ (P. Opler, in Opler, 1962). Siskiyou County: Castle Lake, VII-4-61, 1♂ (S. O. Mattoon). Nr. Dead Horse Summit, 5 mi. SE Bartle, 4500', VII-3-63, 1♀ (C. D. MacNeill, CAS). Tehama County: Mineral, VI-26-30, 1♂ (E. R. Hulbirt). Wilson Lake, VI-26-60, 1♀ (J. W. Tilden); VI-27-62, 1♂ 1♀ (N. La Due); VII-13-64, 1♂ (J. W. Tilden). Tuolumne County: Hog Ranch, 1 mi. E Mather, 4600', VII-27-64, 1♂; VII-29-64, 1♀ (both O. Shields).

OREGON. Linn County: Lost Prairie, 3400', VI-20-65, 4 (E. M. and S. F. Perkins). Lost Prairie, 3400', VI-20-59, 2♀; VI-21-59, 1♂ 1♀ (both E. J. Dornfeld, in Dornfeld, 1959); VI-4-60, 1♂; VI-10-60, 2♂ 1♀ (both R. E. Woodley); VII-22-64, 2♂ 1♀ (E. M. and S. F. Perkins). Tombstone Prairie, 4200', VII-4-59, 1♂ 1♀ (R. E. Woodley, in Dornfeld, 1959).

WASHINGTON. Jefferson County: Ca. 5 mi. SW Bogachiel Pk., Olympic Nat'l Park, ca. 700', VII-15-59, 1♂ 1♀ (J. C. Downey, CM). King County: Seattle vicinity, VII-15-91, 3 larvae (C. V. Piper, CM, one adult is a johnsoni type, in Skinner, 1904). Lewis County: 10 mi. below White Pass, SE Mt. Rainier, ca. 3500', VII-25-62, 1♂ (R. Leuschner). Mason County: V-30-51, 1♂ (AMNH). Lake Cushman, V-30-51, 2♂ 1♀; VI-10-51, 1♂; V-30-52, 3♂ 1♀; VI-10-52, 1♀ (all D. Frechin). Nr. Lake Cushman, VI-1-59, 1♂ (D. Carney); VI-2-61, 2♂ 1♀ (D. V. McCorkle). Stimson Crk., 2 (D. Frechin). Pierce County: Carbonado, 1100', V-18-58, 1♂ (V. Calkins). Nr. The Dalles For. Camp, U. S. Highway 410, VI-15-63, 1♀ (D. V. McCorkle, W. Boehm); VIII-13-64, 3 larvae; IX-1-64, 1 larva (both D. V. McCorkle). Longmire Springs, Mt. Rainier, 2000', 1♀ (USNM). Snohomish County: Garland Mineral Springs, nr. Index, VI-8-60, 1♂; VI-17-61, 1♀ (both D. V. McCorkle). Ca. 3 mi. W Maltby, on rd. to Alderwood Manor, VIII-7-63, 1 larva (D. V. McCorkle). Nr. Verlot, V-13-53, 1♂ (D. L. Bauer). Mason County: nr. Lake Cushman, V-23-59, 1 (R. Cheyne); VI-1-60, 4♂ 2♀ (D. Carney); VI-2-61, 3♂ 1♀ (D. Carney). Berco County: Longmire Spgs., 2500', VI-19-19, 1♀ (C. L. Fox). CAS. Snohomish County: Yukon Park, Stevens Pass Highway, VI-6-41, 1♀ (D. Carney).

RICHARD M. FOX

[Carnegie Museum, Pittsburgh, Pennsylvania, 15213]

Born: Morrisville, Pennsylvania, April 15, 1911.

Education: Swarthmore (Pa.) College, 1929-1932; University of Pennsylvania, 1940-41; A. B. (Honors) University of Pittsburgh, 1946-48; M. S. (Zoology) 1947; Ph. D. 1948.

Service: Lieutenant, U. S. N. R., 1943. Served in Pacific as operations officer on amphibious group staff, later as Commanding Officer, LSM 177; Active in Naval Reserve in Pittsburgh and Colorado Springs; retired as Lt. Commander 1960.

Positions: Research Volunteer in Entomology, Academy of Natural Sciences, Philadelphia, 1935-1941; Curator of Mengel Collections, Reading Public Museum, 1941-1942; University of Pittsburgh; Lecturer 1946, Instructor 1947, Assistant Professor 1948. Colorado College; Associate Professor 1949. Consultant; Dept. of Public Health, El Paso County, Colorado, 1950-1954. Consultant: City of Colorado Springs, 1954-1957. Medical Entomologist and Acting Director: Liberian Institute of American Foundation for Tropical Medicine, 1954-1957; Director of Field Research, Riker Laboratories, Inc. in Liberia, 1958-1959; Associate Curator, Section of Insects and Spiders, Carnegie Museum, Pittsburgh, Pennsylvania, 1960--. Adjunct Prof. , Graduate School, University of Pittsburgh, 1962--.

Interests: Taxonomy of butterflies, phylogeny of same, especially the Nymphaloidea and Ithomiidae; parasitic insects; public health entomology; insect morphology and cytology; biogeography.

Recreation: Sailing, piano, pipe organ, portraits in pastels.

Paper: "Affinities and distribution of Antillean Ithomiidae", J. Res. Lepid. 2(3): 173-184. 1963.



KNOW YOUR AUTHOR

NEWCOMER, ERVAL JACKSON
[1509 Summitview, Yakima, Washington]

Born: Oregon, Illinois, May 5, 1890.

Married: 1913; 3 children

A. B. (Entomology): Stanford University, 1911.

Entomologist: U.S. Department of Agriculture, 1914-1955.

Collaborator: U.S.D.A. 1957-.

Publications: Many papers and bulletins, mostly on fruit insect pests and on *Rhopalocera*.

Interests: Started collecting *Lepidoptera* in 1903. Discontinued in 1914. Started again in 1957. Distribution of *Rhopalocera* in the Pacific Northwest, including their biology.

Paper: "The Synonymy, Variability and Biology of *Lycaena nivalis*"
J. Res. Lepid. 2(4): 271:280.



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THE LIFE HISTORIES OF TWO SPECIES OF SOUTH AFRICAN EUREMA

GOWAN C. CLARK and C. G. C. DICKSON

Cape Town, South Africa

THE OPPORTUNITY IS BEING taken of publishing in full detail, the life-histories of *Eurema hecabe* (L.) and *E. desjardinsii* (Boisd.), with accompanying colour plates in which all the stages are adequately represented. Material from which the two species were reared was obtained on the coast of Natal (Durban or its neighborhood), while the larvae themselves were reared in Port Elizabeth, Cape Province. The records were completed in 1961 and 1955 respectively.

These butterflies frequent more or less open ground, often close to or amongst bushes and trees, especially grassy spots, and they more usually fly not far above the ground, in the characteristic, rather irregular and not rapid manner, of the genus.

Eurema hecabe (L.) (Fig. 1)

Egg. Eggs are laid singly, tucked between rows of small leaves which, at times, tend to fold over them. They are whitish, 0.45 mm. in diameter by 1.7 mm. in height, with some 50 longitudinal ribs cross-braced by some 55-60 ribs. The ribs are very fine. Eggs hatch after 5 days.

Larva. The young larva eats its way out of the egg near the top. It is 1.5 mm. long and is milk-white. It rests on the stalk bearing the fine leaves and feeds in minute runs on the surface of the latter. The larva grows to 3 mm. and then moults where it is resting, 5 days after emergence.

In the second instar larvae are pale green above and yellowish below. They grow to 5 mm. in 5 days.

In the third instar larvae are pale dull green with a yellowish-white subspiracular line, while the ventral portions are very pale green. Larvae grow to 8.5 mm. in 5 days.

In the fourth instar larvae are a darker green throughout, except for a very pale subspiracular line. They grow to 12.5 mm. in 5 days.

In the final instar larvae are generally the same colour as in the previous instar. (In the second to the final instar there is a dorsal stripe which varies from green to salmon-red, edged with yellow. In some final-instar larvae this is missing.) The final-instar larvae strip all the leaves from a frond and then move on to the next one. They grow to 24.5 mm. in 7-8 days. Larvae spin a silken mat on a stalk, fix their anal-claspers into this and then hang down in a loop and pupate.

Pupa. The pupa is 17.5 mm. in length and is secured by cremastral hooks and a girdle, generally head-up. At first the colour is pale watery green, but this deepens to a dull green with brownish markings. The imago emerges after 12-14 days.

There is a succession of broods throughout the year, at least in warmer localities.

Food-plants: *Hypericum aethiopicum* Thunb. (*Hypericaceae*); *Cassia mimosoides* (Leguminosae).

Distribution in Southern Africa. Eastern Cape Province and Natal (generally the more coastal portions); S.W. Africa; Bechuanaland; N. and N.E. Transvaal; Rhodesia; Mozambique.

This species (as regards the imago), with its forms, is fully described by van Son (1949) and a good account of its habits, etc. is given by Swanepoel (1953).

Eurema desjardinsii (Boisd.) (Fig. 2)

Egg. Eggs are laid singly, tucked away between the small leaves of the food-plant. The colour is very pale translucent blue at first, changing to dull yellow. They are 0.4 mm. in diameter by 1.25 mm. in height, with some 40 longitudinal ribs, only a third of which reach the micropile. These ribs are cross-braced by some very fine ribs. Eggs hatch after 5-13 days.

Larva. The young larva emerges near the top of the egg. It is 1.5 mm. in length and of a whitish colour with white setae. It rests on the "midrib" of a frond and its presence causes the sensitive leaves to fold over it. As it feeds the green food gives the larva a green appearance. Small troughs are eaten in the leaves. It grows to 3 mm. after some 5-7 days and then moults where it is feeding.

In the second instar the larva is watery green with a divided green dorsal stripe. It grows to 4.5 mm. in 3-6 days, then moults.

In the third instar larvae are pale green with green dorsal and spiracular stripes, below the latter of which is a white stripe. The ventral portions are whitish. Larvae grow to 7.5 mm. in 4-8 days.

In the fourth instar larvae are a darker green with a darker dorsal and spiracular stripes and the ventral portions whitish. They grow to 12 mm. in 6-8 days.

In the final instar larvae are bluish with darker dorsal and spiracular stripes. The white lateral ridge-stripe is very noticeable owing to the ventral parts being bluish. Larvae strip the leaves off the frond, as in the case of the previous species. They grow 22-23 mm. in 8 days, spin a silken mat on a stalk, and after attaching themselves to it spin a girdle and hang downward in a loop and pupate.

Pupa. The pupa is 18-19 mm. in length and is at first almost transparent pale green. Emergence occurs after some 20 days.

There is a succession of broods in the warmer localities.

Food-plant: *Cassia mimosoides* (Leguminosae).

(The first food-plant given for *Eurema hecabe* would, no doubt, be eaten also by the larva of *E. desjardinsii*.)

Distribution in Southern Africa. This appears to be much the same as for *Eurema hecabe*. In Natal, *E. desjardinsii* is the commoner species of the two and it possibly extends further inland than does *E. hecabe*.

For further information on the butterfly, van Son (1949) and Swanepoel (1953) may be consulted.

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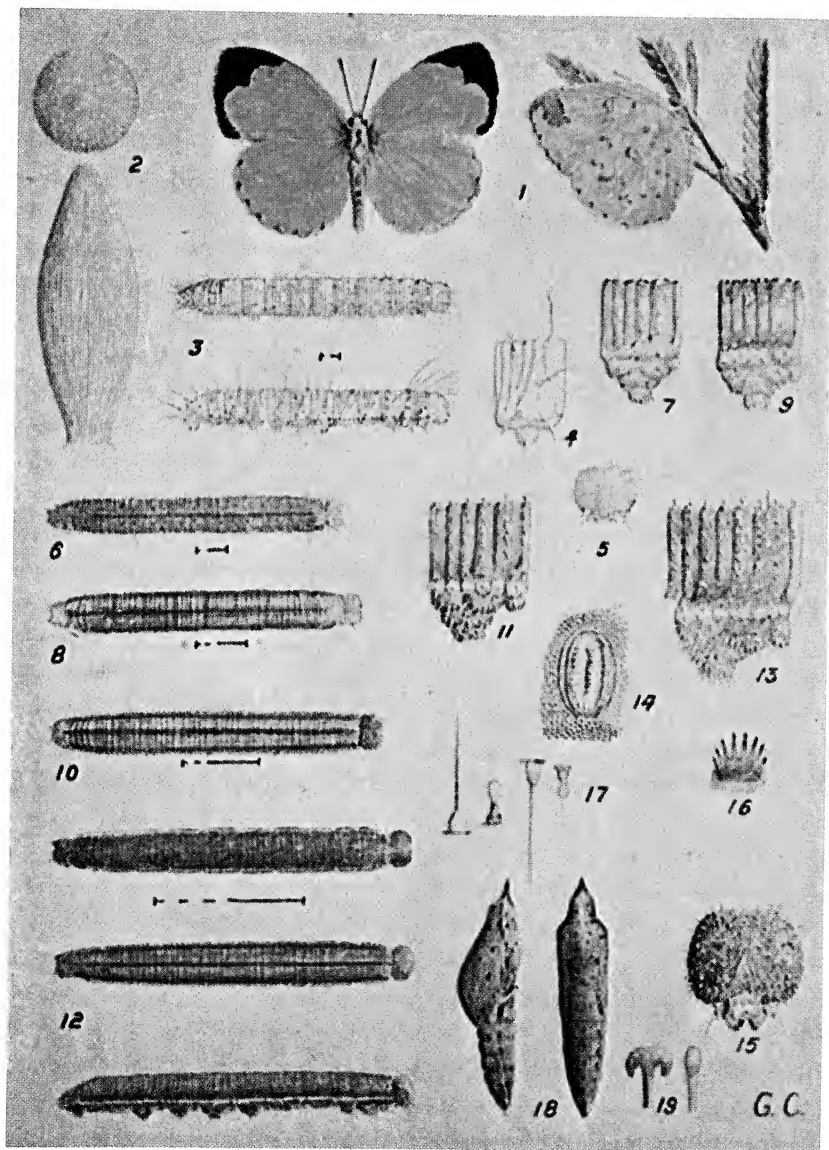


Fig. 1. *Eurema hecabe*. 1. Imago; 2. Egg; 3. Larva, 1st instar; 4. 7th Segment, 1st instar; 5. Head, 1st instar; 6. Larva, 2nd instar; 7. 7th Segment, 2nd instar; 8. Larva, 3rd instar; 9. 7th Segment, 3rd instar; 10. Larva, 4th instar; 11. 7th Segment, 4th instar; 12. Larva, final instar; 13. 7th Segment, final instar; 14. Spiracle; 15. Head final instar; 16. Anal comb; 17. Setae, much enlarged; 18. Pupa, cremastral hooks much enlarged; Food Plant: *Cassia mimosides*.

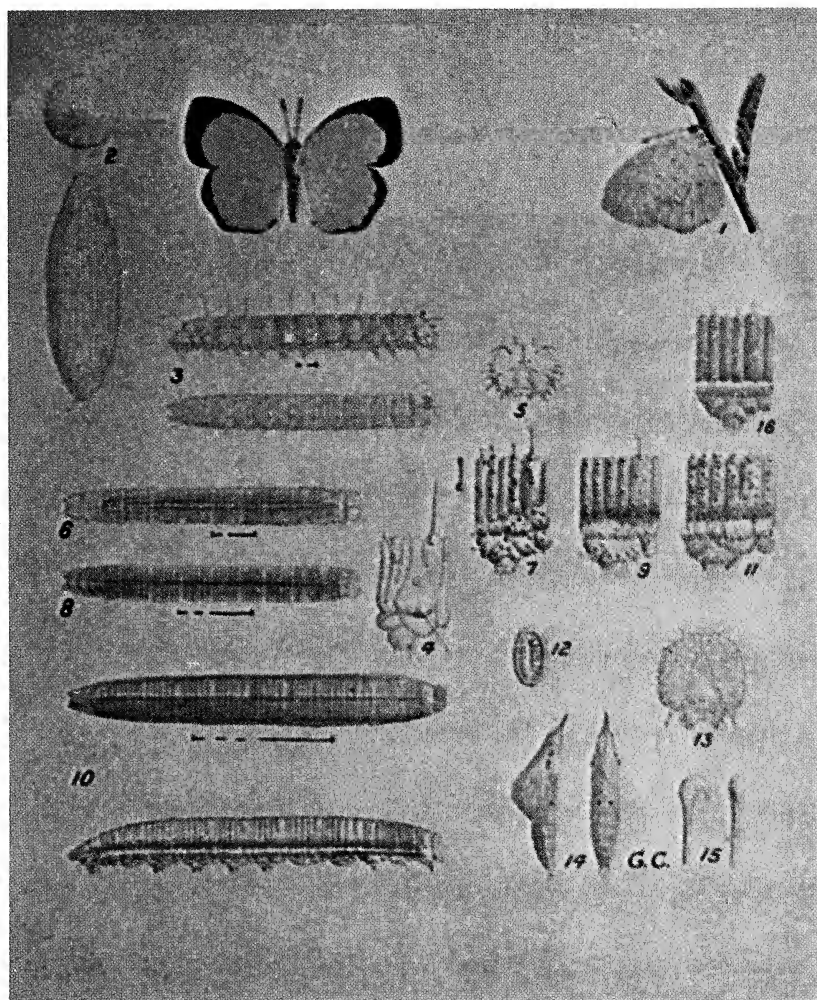


Fig. 2. *Eurema desjardinsi*. 1. Imago; 2. Egg; 3. Larva on hatchings; 4. 7th Segment, 1st instar; 5. Head, 1st instar; 6. Larva, 3rd instar; 7. 7th Segment, 2nd instar; 8. Larva, 4th instar; 9. 7th Segment, 4th instar; 10. Larva, final instar; 11. 7th Segment final instar; 12. Spiracle enlarged; 13. Head, final instar; 14. Pupa; 15. Cremastral hooks much enlarged; 16. 7th Segment, 3rd instar; Food Plant: *Cassia mimosides*.

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A REVIEW OF THE
WEST INDIAN "CHORANTHUS"

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INTRODUCTION

WHEN HARRY K. CLENCH asked me to identify a single hesperiine skipper in connection with his forthcoming paper on Bahaman butterflies it looked like a rather simple, straightforward task. The job became more difficult when the specimen was a female of an undescribed *Choranthus*, apparently the one mentioned by Rindge (1955). It was necessary to examine the female genitalia of all *Choranthus* to correctly place the new species, and it became evident that the genus as defined by Evans (1955) was not a homogeneous assemblage of skippers. Accordingly, the male genitalia of all "*Choranthus*" were examined, as were the terminalia of both sexes of representative *Poanes* and *Paratrytone*, and comparisons were made.

The paper which follows reflects the conclusions reached in this study. One species of "*Choranthus*" is placed in *Paratrytone*, another is the type of a new genus and the genus *Choranthus*, s. s., is divided into two species groups.

SYSTEMATIC REVISION

Since Evans' (1955) key to *Choranthus* is inadequate and contains some fundamental errors, new keys will be provided throughout this paper.

A Key to the Genera of "*Choranthus*"

1. Third segment of palpus very short, barely protruding beyond the hairs of the second; gnathoi narrow, free and about as long as uncus; valva broad and distally rounded *Paratrytone* Godman.
- 1¹. Third segment of palpus prominent and protruding well beyond the hairs of the second; gnathoi fused and developed into a spatulate structure, or if not, the valva is pointed. 2.
2. Gnathoi fused into a spatulate structure; median projections of lamella antevaginalis prominent; larger skippers (forewing length at least 14 mm.) *Choranthus* Scudder.
- 2¹. Gnathoi free and pointed; lamella antevaginalis simple; small skippers (forewing length about 10 mm.) *Parachoranthus*, n. gen.

Genus **PARATRYTONE** Godman, 1900

Paratrytone Godman, 1900. Biol. Cent.-Amer., Rhop. 2: 487. Type-species:

Paratrytone rhexenor Godman, by original designation.

Antenna not quite half as long as forewing costa; club occupying the distal quarter of the shaft and bent beyond its thickest point to a tapering apiculus; nudum variously 4/8, 5/7 and 5/8. Palpus semi-porrect; third segment short, barely protruding beyond hairs of the second. Midtibia armed with a pair of well to moderately well-developed terminal spurs; hindtibia with two pairs of well-developed spurs. Wing venation as in other members of the *Poanes-Atrytone* generic complex; forewing stigma, when present, bipartite, the posterior member extending from about the middle of 2A to just below the origin of Cu₂, and the anterior member extending from just above and distad of the origin of Cu₂ to just below and distad of the origin of Cu₁. The male genitalia are characteristic: the uncus is long, slender and undivided; the gnathoi are nearly as long as the uncus, narrow and free; the valvae are broad and distally rounded and the penis is enlarged distad and adorned with prominent cornuti. The female genitalia lack the median posteriad projections of the lamella antevaginalis characteristic of *Choranthus* and more nearly resemble those of *Poanes* Scudder.

This genus is very close to *Poanes* and was formerly combined with it (see Lindsey, 1921: 84-88). The two genera differ chiefly in the shorter, more abrupt antennal club of *Paratrytone* and in the form of the male genitalia. Nine Nearctic and Neotropical skippers are referred to this genus by Evans (1955: 349-352), and one West Indian species which he places in *Choranthus* belongs here.

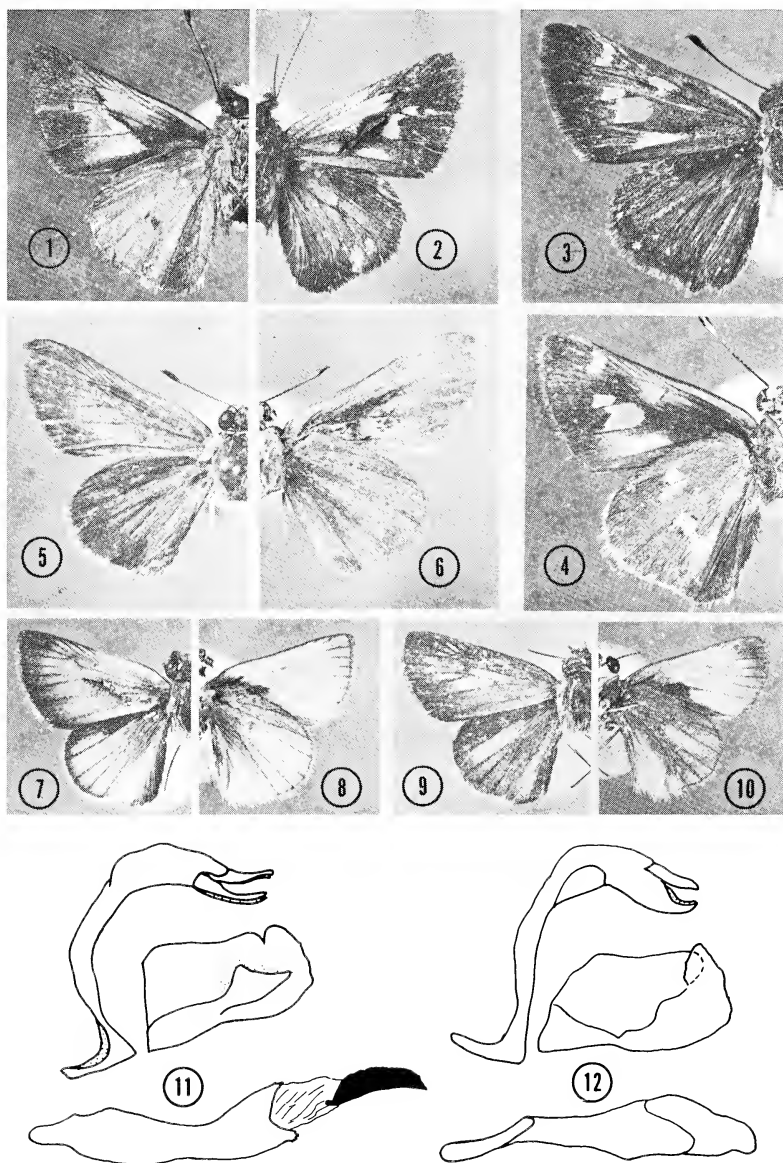
Paratrytone batesi (Bell), 1935

Figs. 1, 2 (♂), 3, 4 (♀), 11 (♂ gen.), 19 (♀ gen.)

Poanes batesi Bell, 1935. Psyche, 42: 63 (La Selle Mtns., Haiti).

In his detailed original description Bell correctly associated this species with the *polyclea* Godman-*aphractoia* Dyar section of *Paratrytone* (which he considered synonymous with *Poanes*), but Evans (1955: 354) placed *batesi* in *Choranthus* with the other West Indian members of the *Poanes* complex. From members of *Choranthus* the present species may be readily distinguished by the short terminal segment of the palpus and by the configurations of both the male and female genitalia. For comparison I have also figured the genitalia of both sexes of *Paratrytone rhexenor* in figs. 12 (♂) and 20 (♀). Inasmuch as *batesi* has not been figured previously, I here figure two paratypes.

This species has thus far been reported only from the mountains of Hispaniola at elevations of 5000 to 7400 feet in the pine forest or at the edge of the cloud forest (Bell, 1935: 67).



1. *Paratrytone batesi* (Bell), ♂ paratype, under surface; La Selle Mtns., HAITI. 2. Same, upper surface. 3. *P. batesi*, ♀ paratype, upper surface; La Selle Mtns., HAITI. 4. Same, under surface. 5. *Choranthus richmondi*, new species, ♀ holotype; White Point, Great Guana Cay, Exuma Islands, BAHAMAS. Note that this specimen has a hole in the forewing below the origin of Cu_2 and above $2A$. 6. Same, under surface. 7. *Parachoranthus magdalia* (Herrich-Schaffer), ♂, upper surface; Santiago, CUBA. 8. Same, under surface. 9. *P. magdalia*, ♀, upper surface; Cristo, Oriente, CUBA. 10. Same, under surface. 11. *Paratrytone batesi* (Bell), ♂ genitalia. 12. *Paratrytone rhexenor* Godman, ♂ genitalia.

Genus **CHORANTHUS** Scudder, 1872

Choranthus Scudder, 1872. Rept. Peabody Acad. Sci., 1871: 79. Type-species: *Hesperia radians* Lucas, by original designation.

Antenna approximately half the length of forewing costa; club occupying the distal quarter of the shaft and bent abruptly beyond its thickest point to a tapering apiculus one-third as long as the club, nudum 4/8 (*radians* group); or tapering more gently to an apiculus half as long as the club, nudum 5/8 (*lilliae* group). Palpus semi-porrect; third segment moderately long, extending well beyond the hairs of the second. Midtibia armed with well-to moderately well-developed terminal spurs (never smooth, as stated by Evans, 1955: 352); hindtibia with two pairs of spurs. Wing venation and stigma about as in *Paratrytone*, but stigma absent in *vitellius* (Fabricius). Male genitalia with the gnathoi fused into a broad spatulate structure, most prominent in the *radians* group, and a shorter, heavier uncus than in *Paratrytone*, particularly in the *lilliae* group. The female genitalia are characterized by median posteriad projections of the lamella antevaginalis, best shown in the *radians* group, and by the shield-like lamella postvaginalis.

Choranthus is an endemic West Indian genus and is the chief representative of the *Poanes* complex in that area. Many authors (e. g., Lindsey, Bell and Williams, 1931: 108-113) have considered *Choranthus* a synonym of *Poanes*, but more recent writers have considered the genera to be separate. The form of both the male and female genitalia will serve to separate *Choranthus* from the basically continental members of the *Poanes* complex. Evans (1955: 352-254) includes seven species in the present genus. Two of those species are here removed, and one new one is described, so six species remain in the genus. These species are further separated into two species groups, of which the *radians* group is considered the more advanced on the basis of the more elaborate development of the gnathoi and the more highly developed median projections of the lamella antevaginalis.

A Key to the Species of *Choranthus* Scudder

1. Antennal club gently tapering to an apiculus half as long as the club, nudum 5/8; uncus very short (see figs. 16, 17); large insects (forewing length greater than 17 mm.) *lilliae* group, 2.
- 1¹. Antennal club abruptly ending in an apiculus one-third as long as club, nudum 4/8; uncus longer (see figs. 13-15); smaller insects (forewing length less than 17 mm.) *radians* group, 3.
2. ♂ above with complete dark forewing extradiscal band; ♀ above with extensive fulvous forewing markings; Jamaica. *lilliae* Bell.
- 2¹. ♂ above with an incomplete dark forewing extradiscal band; ♀ above with restricted fulvous and cream-colored markings on the forewing; Puerto Rico. *borincona* (Watson).
3. ♂ with no stigma; ♀ above bright yellowish-fulvous; Puerto Rico. *vitellius* (Fabricius).
- 3¹. ♂ with a stigma; ♀ above either fuscous, or if fulvous, a dark, reddish-fulvous. 4.
4. ♂ ♀ hindwing below fuscous with prominent paler veins; Cuba and Florida. *radians* (Lucas).
- 4¹. ♂ ♀ below without prominent paler veins. 5.

5. ♂ ♀ hindwing below light fulvous-gray except for bright fulvous anal fold; Hispaniola and Florida. *haitensis* Skinner.
 51. ♂ unknown; ♀ hindwing below heavily overscaled with green except anal fold which is bright fulvous; Bahamas. *richmondi*, n. sp.

the LILLIAE group

These are larger skippers (forewing length 17-19 mm.) than members of the *radians* group. They are further characterized by the form of both the male and female genitalia and by the more tapered antennal club with a longer apiculus. Two species are recognized, one from Jamaica and the other from Puerto Rico.

Choranthus lilliae Bell, 1931

Figs. 17 (♂ gen.), 26 (♀ gen.)

Choranthus lilliae Bell, 1931. Ent. News 42: 220 (Bath, St. Thomas Parish, Jamaica).

Males of the present species may be distinguished from those of *borincona*, the only other large *Choranthus*, by the complete dark extradiscal band on the upper surface of the forewing. The females are dark, like those of *borincona*, but the forewings are strongly flushed with fulvous on the upper surface in *lilliae*, and the forewing markings are more diffuse. The gnathoi are less well-developed than those of *borincona*, and the penis is only slightly longer than the valvae. The female genitalia differ from those of *borincona* as shown in our figures; the development of the lamella antevaginalis is most aberrant in *lilliae*. Both sexes of this attractive skipper have been figured by Avinoff and Shoumatoff (1941).

All the specimens of *lilliae* that have come to my attention have been taken at, or very near, the type-locality.

Choranthus borincona (Watson), 1937

Figs. 16 (♂ gen.), 25 (♀ gen.)

Godmania borincona Watson, 1937. American Mus. Novitates, (906): 9 (Adjuntas, Puerto Rico).

The males of this species may be readily separated from those of *lilliae* by the incomplete dark extradiscal band on the forewing above, whereas the females are characterized by the restricted fulvous of the upper surface and the tendency for the forewing spots to be cream-colored. The valvae are quite different from those of other *Choranthus*, but the typical development of the gnathoi indicates the correct position of this skipper. The male is figured by Comstock (1944), and the female by Dewitz (1877), as *silus*).

Borincona is known only from Puerto Rico; all the specimens I have seen are from lower elevations. It does not appear to be common.

the **RADIANS** group

These are smaller skippers (forewing length 14-17 mm.) than those of the *lilliae* group. The male and female genitalia are distinctive, and the antennal club ends more abruptly in a shorter apiculus, as indicated in the generic description. Four species are included, one each from Puerto Rico, Hispaniola, Cuba and the Bahamas, and two of these species have been taken in Florida.

Choranthus radians (Lucas), 1857

Figs. 13 (♂ gen.), 22 (♀ gen.)

Hesperia radians Lucas, 1857. Sagra's Hist. Cuba, 7: 650 (Cuba).

= *Hesperia ammonia* Plotz, 1883. Stettiner Ent. Zeitg., 44: 201 (no locality cited, presumably Cuba).

= *Hesperia magica* Plotz, 1883. Stettiner Ent. Zeitg., 44: 202 (Cuba).

= *Pamphila streckeri* Skinner, 1893. Ent. News, 4: 211 (Florida).

= *Choranthus radians* f. *bellus* Draudt, 1924. in A. Seitz, Macrolepid. World, 5: 941; pl. 182h (Cuba).

The females, and to a lesser extent the males, of this species are polymorphic, but I can detect no differences in either the male or female genitalia which correlate with the superficial ones. Draudt (1924: 941) recognized three forms, and Evans

1955: 353) two, but all the material is best referred to *radians* with no further qualification. The very highly developed gnathoi will distinguish the males of this species from those of all other *Choranthus*, and the shield-shaped lamella postvaginalis, while not so broad as in the next species, is broader than those of *haitensis* or *vitellius*. Superficially this species may be separated from all others by the pale veins on the under surface of the hindwing. *Radians* has been figured by Draudt (1924), Holland (1931), Klots (1951) and particularly well by Williams (1931).

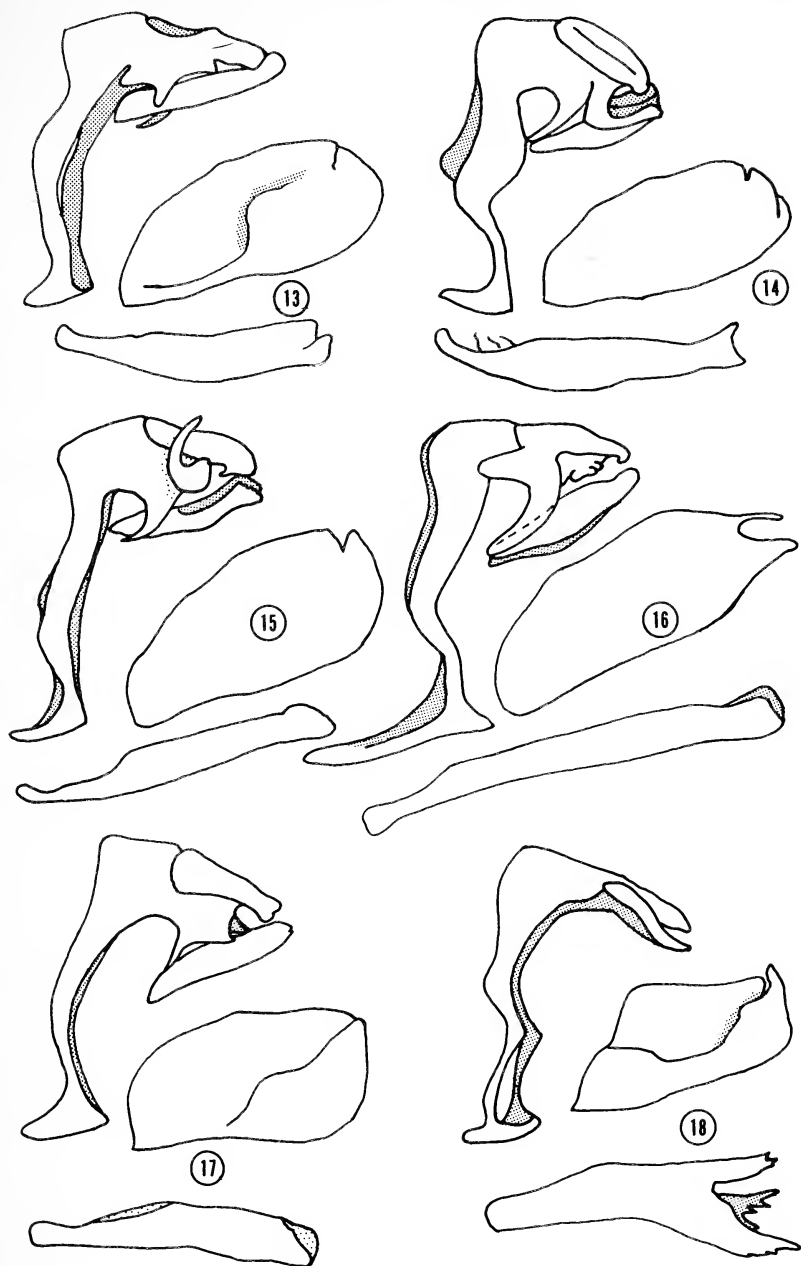
This species is apparently abundant throughout Cuba and has been reported from Florida. It may be an occasional introduction into the United States, not a resident butterfly (Klots, 1951: 251-252).

Choranthus richmondi, new species

Figs. 5, 6 (♀), 21 (♀ gen.)

Female: Head, thorax and abdomen blackish-brown above sprinkled with greenish and fulvous hairs, heaviest on the head and patagia. Antenna dark brown above, fulvous at the base of the club; below the shaft is ringed with alternating chocolate-brown and light fulvous; nudum dull brown. Palpus brownish-black above and pale fulvous below; cheeks light grayish-fulvous. Thorax and abdomen beneath densely covered with tan hairs intermingled with a few green ones. Legs thickly covered with bright fulvous hairs.

Upper surface of forewing dark fuscous with a darker patch near the end of the cell corresponding to that of other members of the group. The area bounding the cell, from the origin of R₁, around the cell and thence



Figs. 13-18: ♂ genitalia of "Choranthus". 13. *Choranthus radians* (Lucas). 14. *C. haitiensis* Skinner. 15. *C. vitellius* (Fabricius). 16. *C. borincona* (Watson). 17. *C. lilliae* (Bell). 18. *Parachoranthus magdalia* (Herrich-Schaffer).

across the wing to near the middle of 2A, is thinly dusted with fulvous scales and corresponds to the light patch on females of other *radians* group skippers. The hindwing is also dark fuscous with long basal fulvous hairs and a poorly defined discal patch of the same color interrupted by darker veins. The fringes of both wings are grayish-brown.

Under surface of forewing fuscous, darker from the base to the end of the cell and almost to the inner margin. Costa heavily overscaled with bright fulvous; the apex, margin and extradiscal areas are thickly overscaled with mixed fulvous and green. Hindwing likewise fuscous heavily dusted with mixed fulvous and green scales, fulvous alone in the anal area. There are no discal markings, and the veins are not paler than the ground color.

Length of forewing of Holotype ♀, 15.5 mm.; of Paratype ♀, 16.5 mm.

The female genitalia are characteristic of the *radians* group as regards the paired median posteriad projections of the lamella antevaginalis. The broad, shield-like lamella postvaginalis is similar to that of *radians*, but it is broader in the present species.

Described from two females from the Exuma Islands, Bahamas.

HOLOTYPE ♀: White Point, Great Guana Cay, Exuma Islands, BAHAMAS; 17.vii.1965 (N. D. Richmond); ♀ genitalia slide no. M-1458 (Lee D Miller).

PARATYPE ♀: Exuma Cays, Bitter Guana Cay, BAHAMAS; 13.i.1953 (L. Giavannoli); ♀ genitalia slide no. G2410 (American Museum of Natural History).

The Holotype is in the collection of Carnegie Museum (C. M. Ent. type series no. 513), and the Paratype is in the collection of the American Museum of Natural History.

I take great pleasure in naming this skipper for my friend and colleague, Neil D. Richmond, Curator of Amphibians and Reptiles, Carnegie Museum, who collected the Holotype. His collections have enriched the entomological holdings of Carnegie Museum for many years.

This species is the "*Choranthus* species" referred to by Rindge (1955) in his report of the Bahaman butterflies. The specimen he noted is the Paratype.

C. richmondi is closest to *radians*, and probably *radians* was the ancestral species of the Bahaman insect. The Exuma Islands are those nearest eastern Cuba and lie along the "main line" of dispersal from Cuba to the remainder of the Bahamas. From the systematic proximity of *radians* and *richmondi*, I expect the male of the latter to be rather like that of *radians*, perhaps darker, and with at least some green overscaling on the hindwing beneath. I doubt that the conspicuously paler veins of the hindwing below which identify *radians* will be apparent in the present species.

Choranthus haitensis Skinner, 1920

Figs. 14 (♂ gen.), 23 (♀ gen.)

Choranthus haitensis Skinner, 1920. Ent. News, 31: 187 (Haiti).

On the upper surface this species resembles *radians*, but the under surface of the hindwing is light fulvous-gray with no trace of the paler veins which distinguish *radians*. The gnathoi are not as well-developed into the distinctive spatulate structure as they are in *radians*, and the median posteriad projections of the lamella antevaginalis are not as prominent as in either *radians* or *richmondi*. This butterfly is figured by Comstock (1944).

C. haitensis has been reported from Hispaniola, Florida and Puerto Rico, though Comstock (1944: 563) expressed some doubt as to its occurrence in Puerto Rico. The specimens from other than Hispaniola undoubtedly are strays, and since this species has been recently and authentically reported from Florida (see Klots, 1951: 251-252) its occurrence in Puerto Rico as an occasional windblown stray is not unexpected. Furthermore *haitensis* should be sought in Cuba, though I have seen no records from that island to date.

Choranthus vitellius (Fabricius), 1793

Figs. 15 (♂ gen.), 24 (♀ gen.)

Hesperia vitellius Fabricius, 1793. Ent. Syst.: 327 ("American meridionalis Insulis").= *Hesperia huebneri* Plotz, 1883. Stettiner Ent. Zeitg., 44: 199 (West Indies").= *Pamphila insularis* Mabille, 1891. C.-R. Soc. Ent. Belgique, 35: 174 (St. Thomas, Virgin Islands).= *Pamphila portensis* Mabille, 1891. C.-R. Soc. Ent. Belgique, 35: 184 (Puerto Rico).= *Adopaea commodus* Kirby, 1903. Samml. exot. Schmett., Neue englische facsimile ausgabe, 3: 110 (replacement name for *vitellius* Hubner, wrongly believed to be different from *vitellius* Fabricius).

This species is the only *Choranthus* which lacks the prominent, bipartite forewing stigma, thus serving to distinguish the males. The females are much more ochreous on the upper surface than are those of other species in the genus. The male and female genitalia are quite distinctive, as may be seen in the figures. Comstock (1944) figures this skipper.

Vitellius is abundant in Puerto Rico and the Virgin Islands, apparently flying throughout the year. Evans (1955: 353) also records specimens from Guatemala, Florida and the Amazon, all of which are probably based on mislabelled specimens. At best any of these records could represent strays, not permanent members of the faunas of these countries.

Genus PARACHORANTHUS, new genus

Type-species: *Hesperia magdalia* Herrich-Schaffer, 1863.

Antenna about two-fifths the length of the forewing costa; club occupying the distal third of antenna and tapering gradually beyond its thickest point to an apiculus which is half as long as the club; nudum 6/6. Palpus semi-porrect, third segment fairly long and extending well beyond the hairs of the second. Midtibia armed with a pair of well-developed, terminal spurs (not three, as claimed by Evans, 1955: 352); hindtibia with two pairs of spurs. Wing venation and placement of stigma as in other members of the *Poanes* complex; forewing more rounded than in other "*Choranthus*", and the stigma is thinner and less prominent. The male genitalia show affinities to both the *Poanes* complex and to *Polites* (especially *vibex*) and almost no similarity to those of *Choranthus*, particularly as regards the long, narrow uncinal structures, the pointed valvae and the heavily armed penis. The female genitalia are not as massive as those of other West Indian *Poanes* group skippers, and again the female terminalia resemble those of some *Polites*.

One species is included in this genus.

***Parachoranthus magdalia* Herrich-Schaffer), 1863**

Figs. 7, 8 (♂), 9, 10 (♀), 18 (♂ gen.), 27 (♀ gen.)

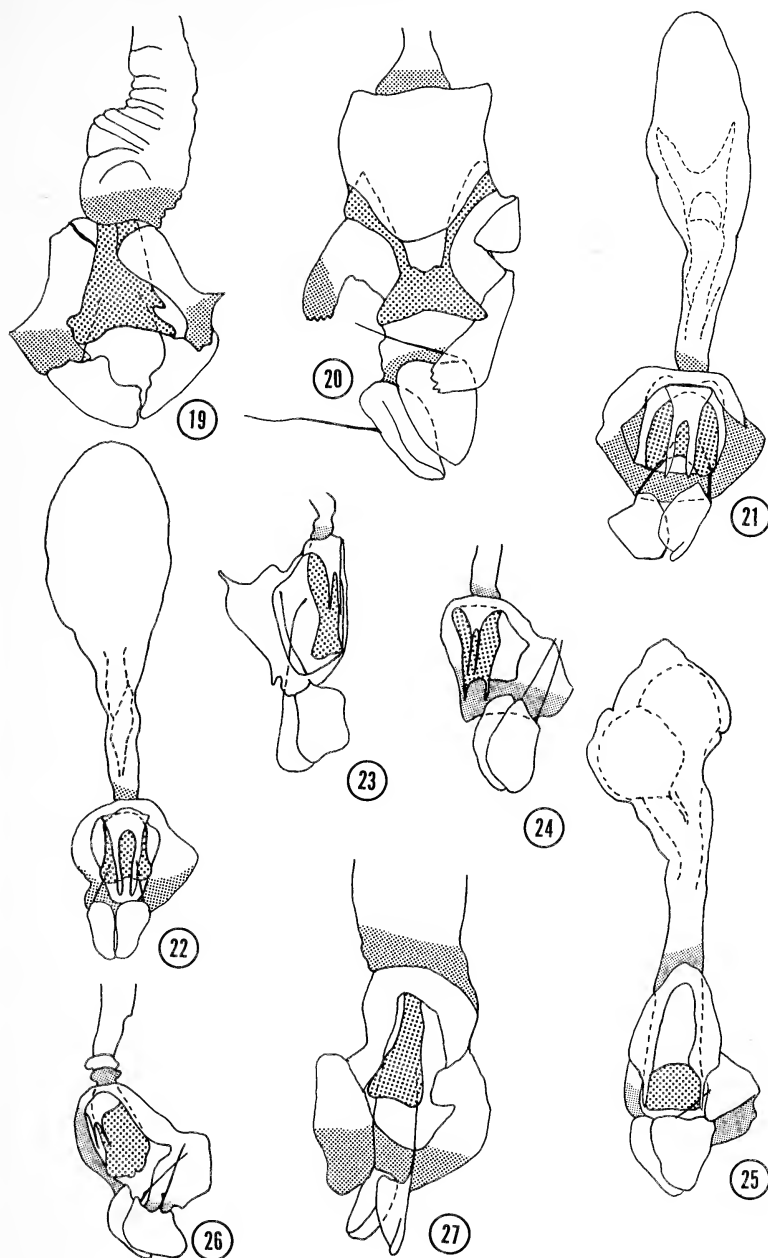
Hesperia magdalia Herrich-Schaffer, 1863. Corresp.-blatt Zool.-Min. Verein Regensburg, 17: 143 (Cuba).

This species may readily be distinguished from all other "*Choranthus*" by its small size (forewing length seldom exceeds 10 mm.), its more rounded wings and by the configurations of both the male and female genitalia. Since I have seen no adequate figures of this skipper, I am figuring a pair from Oriente, Cuba.

This skipper is thus far known only from Cuba, and all the specimens I have seen are from the eastern part of the island. Apparently *magdalia* is abundant where it is found (Williams, 1931: 313).

**GEOGRAPHIC DISTRIBUTION
AND ZOOGEOGRAPHIC CONSIDERATIONS**

It is interesting that there is a member of the continental genus *Paratrytone* on Hispaniola, and the absence of other members on Jamaica and especially Cuba is intriguing. It is evident that *batesi* was derived from the *polyclea* branch of the genus, a montane Mexican and Central American complex. The problem, then, is how and when did the progenitor of *batesi* arrive in Hispaniola "without leaving a trail"? Several possibilities are evident, two of which seem quite reasonable. The ancestral stock of *batesi* may have arrived in Hispaniola "the hard way", that is, this hypothetical insect was blown across the Caribbean from Central America and settled substantially where it is today. The other plausible explanation is that the *batesi* progenitor migrated to Hispaniola from Mexico by way of Cuba, and the Cuban



Figs. 19-27: ♀ genitalia of *Choranthus* and its relatives. 19. *Paratrytone batesi* (Bell), paratype. 20. *Paratrytone rhexenor* Godman. 21. *Choranthus richmondi*, new species, holotype. 22. *C. radians* (Lucas). 23. *C. haitensis* Skinner, paratype. 24. *C. vitellius* (Fabricius). 25. *C. borincona* (Watson). 26. *C. lilliae* Bell. 27. *Parachoranthus magdalia* (Herrich-Schaffer).

insects were subsequently exterminated, possibly during the Pleistocene. These, then, are the two most reasonable answers to the question of how this species became established where it is today; now we must ascertain, if possible, when this occurred.

The *polyclea* group of *Paratrytone* from whence *batesi* arose is a tightly-knit group of skippers replacing one another on various mountain ranges of the continent. Nevertheless, all of these species retain very similar superficial, as well as genitalic, characteristics. Whereas genitally *batesi* is clearly a member of this complex, superficially it resembles no other *Paratrytone*; in short, it is the most aberrant member of the genus. This fact, all other things being equal, suggests either a higher evolutionary rate or long isolation. A higher evolutionary rate is generally associated with a small population, whereas a lower rate indicates a larger gene pool. If collection data are at all valid for determining the relative abundance of insects, and they are admittedly poor guidelines, it would appear that the population of *batesi* is no smaller than that of other *polyclea* group skippers; in fact, it is much larger than the apparent populations of other members; there being fewer than ten known specimens of *aphractoia*, and to my knowledge the type of *polyclea* is unique. *Batesi* was described from a series of twenty-one specimens. While these data indicate that the population of *batesi* is at least as high as that of almost any other member of the genus, they are not in themselves proof of this contention. The area occupied by *batesi* is as large or larger than the known ranges of several of the other species (*aphractoia* is known from Popocatepetl, Mexico, only), and assuming comparable population densities, the Hispaniolan insect should have a relatively large population. All members of the *polyclea* complex, including *batesi*, are cool-tolerant species which at first glance could indicate dispersal and differentiation solely within the Pleistocene. A glance, however, at some of the closely related hesperiids which undoubtedly have separated during the Pleistocene in temperate North America (such as *Poanes hobomok* and *taxiles*) shows that such species have diverged far less than have members of the *polyclea* complex, and particularly *batesi* from the other members. While the Pleistocene has been a potent force in the evolution, isolation and imposition of conditions upon these insects, it seems inescapable that these species, particularly *batesi*, were at least somewhat distinct before the advent of the Pleistocene cooling. I assume that *batesi*'s progenitor arrived on Hispaniola sometime during the Tertiary, as suggested for the ithomiids by Fox (1963).

Parachoranthus magdalia is a species which appears to have done little moving since it arrived in the Antilles. It is apparently abundant in eastern Cuba, but it has not been reported elsewhere. There are similarities between this butterfly and members of both the *Poanes* and *Polites* complexes, both of which have proliferated on the mainland. The intermediate position held by *Parachoranthus* indicates its arrival in the West Indies preceded the separation of the *Poanes* and *Polites* complexes on the mainland. This suggests great antiquity for the Cuban insect, and many of the arguments put forth for *batesi* above also apply here; perhaps *Parachoranthus* is as old as any of the present-day Antillean butterflies.

A very interesting pattern of distribution is found in the genus *Choranthus*, s. s. In the *radians* complex, the one systematically furthest removed from continental *Poanes*, a linear relationship exists with the Bahaman *richmondi* closest to the Cuban *radians*, which in turn is the closest relative of the Hispaniolan *haitensis*, the closest (though in this case not very close) relative of the Puerto Rican *vitellius*. This pattern is compatible with most theories of distribution throughout the Antilles: species found in the western Bahamas should logically have been derived from Cuban stocks, and the main route of dispersal of organisms into Puerto Rico is *via* Hispanola, whether directly from there or ultimately from Cuba. Furthermore, the systematic proximity of these four species indicates that at least some of them are recent migrants to the areas they now inhabit. This is particularly true of *richmondi*, and it is entirely possible that *richmondi* arrived in the Bahamas and differentiated during or after the Pleistocene, a pattern often cited by Clench (1964). *Vitellius*, the most aberrant member of the *radians* complex, is a less likely Pleistocene immigrant; it probably arrived and at least partially differentiated in the late Tertiary, completing its differentiation as we now see it *in situ* during the Pleistocene. The relationship of *radians* and *haitensis* is very close (certainly one was derived from the other), and the definitive separation probably took place during the Pleistocene. It is difficult to ascertain whether Cuba or Hispaniola was the center of the *radians* group — either as the center could account for the present-day distribution of the complex.

Finally we must consider the *lilliae* group of *Choranthus*. This group is represented at low to moderate elevations in both Jamaica (*lilliae*) and Puerto Rico (*borincona*), but the group is strangely absent from Hispaniola. Despite the lack of present-

day members on Hispaniola (the island is poorly collected, and one may yet be found there), the logical pattern of distribution of the *lilliae* group centers on that island. Jamaica is an "eddy" in the mainstream of trans-Antillean migration and can hardly be considered the center of any complex. The same may be said of Puerto Rico, though it occupies an end in the distributional chain, as indicated in the discussion of the *radians* group. Therefore, it is necessary to search for an undiscovered or extinct Cuban and/or Hispaniolan ancestor of the *lilliae* group skippers. The existence of an insect in Hispaniola alone is easier to justify than that of not only the Hispaniolan skipper, but also a Cuban one, so Hispaniola looks more like the logical center of the dispersal of the present group. The two species in question are the most aberrant members of the genus *Choranthus*; indeed, it was tempting to erect a new genus for them. The differences cited are of a fundamental nature involving conservative characters, and the conclusion seems inescapable that this divergence required BOTH isolation and time. The two species in the present group certainly diverged early from the stock which produced the *radians* group, and at least the two complexes seem to have been distinct before the advent of the Pleistocene cooling. The stocks on Jamaica and Puerto Rico were almost certainly there before the Pleistocene and remained there, perhaps becoming full species only then. Pleistocene cooling, furthermore, may have been responsible for the extermination of the Hispaniolan stock of the *lilliae* group, if, indeed, it is extinct.

With the exception of *Parachoranthus* mentioned earlier, it appears that the distribution of *Choranthus* and its allies was centered in Hispaniola. Perhaps it was there that the genus *Choranthus* evolved into the two basic groups, and it seems likely that several species had partially or completely differentiated by the Pleistocene, thus paralleling the situation postulated for the Ithomiidae by Fox (1963). The present distribution of *Parachoranthus magdalia* and the probable source of *Choranthus richmondi* strongly supports the existence of a southeastern Cuban Pleistocene refugium mentioned by Clench (1964: 257-265). His postulated wholesale Quaternary extermination of the butterfly fauna of Puerto Rico and the subsequent recolonization by Hispaniolan stocks is not supported by the evidence in *Choranthus*; there are two endemic Puerto Rican species, more than on any other island, and these are very distinct from their relatives, more so than are the Cuban or Hispaniolan representatives. It is therefore necessary to assume that these species survived

the Pleistocene *in situ* and were not Pleistocene or post-Pleistocene immigrants from Hispaniola. In fairness, I point out that Clench (in litt.) has said, "I agree that your two *Choranthus* survived at least one glaciation in Puerto Rico . . . Any species that could tolerate the cooling could have. Such species today need not be exclusively montane, but they should occur up into montane conditions (*i. e.*, *ca.* 2000 feet +)." I remain unconvinced, however, that one glaciation is sufficient to produce the differentiation shown by the Puerto Rican *Choranthus*.

ACKNOWLEDGEMENTS

I would like to thank Dr. Frederick H. Rindge, American Museum of Natural History, and Mr. William D. Field, U. S. National Museum, for their cooperation and for the loan of specimens. Particular thanks are due Mr. Clench, not only for the loan of specimens, but also for his comments upon the manuscript and his suggestions, all of which are gratefully acknowledged, but not all of which have been incorporated into this paper.

The specimen which triggered the entire project was collected by Mr. Richmond when he was a member of the 4th expedition of the Bahama Biological Survey, under the auspices of the Lerner Marine Laboratory of the American Museum of Natural History and the Office of Naval Research, Project No. 552(07).

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A NEW SPECIES OF BASILODES FROM THE SOUTHWESTERN UNITED STATES (NOCTUIDAE)

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SPECIMENS OF *BASILODES*¹ recently sent to me by Andre Blanchard of Houston, Texas proved to belong to an undescribed species. I take pleasure here in describing the species as new and naming it in honor of the collector.

***Basilodes blanchardi* n. sp.**

Description:

Adult male. Size medium, fore wing length: 14-15 mm.

Upper surface of fore wing lemon-yellow, flecked with scattered white scales; coastal margin mixed black and white scaled; subcostal area white; cinnamon-brown (some scales light-tipped) spreading in from outer margin (as in most members of *B. rugifrons* group), hexagonal or quadrate macula of inner margin (typical of other members of *B. rugifrons* group) and other markings absent except for small caudo-basal area of brown, white-tipped scales; fringe double, inner row of black, white-tipped scales, outer row of grey, white-tipped scales; fringe of inner margin white.



Fig. 1: *Basilodes blanchardi*, n. sp., paratype female, Basin, Big Bend N. P., Texas.

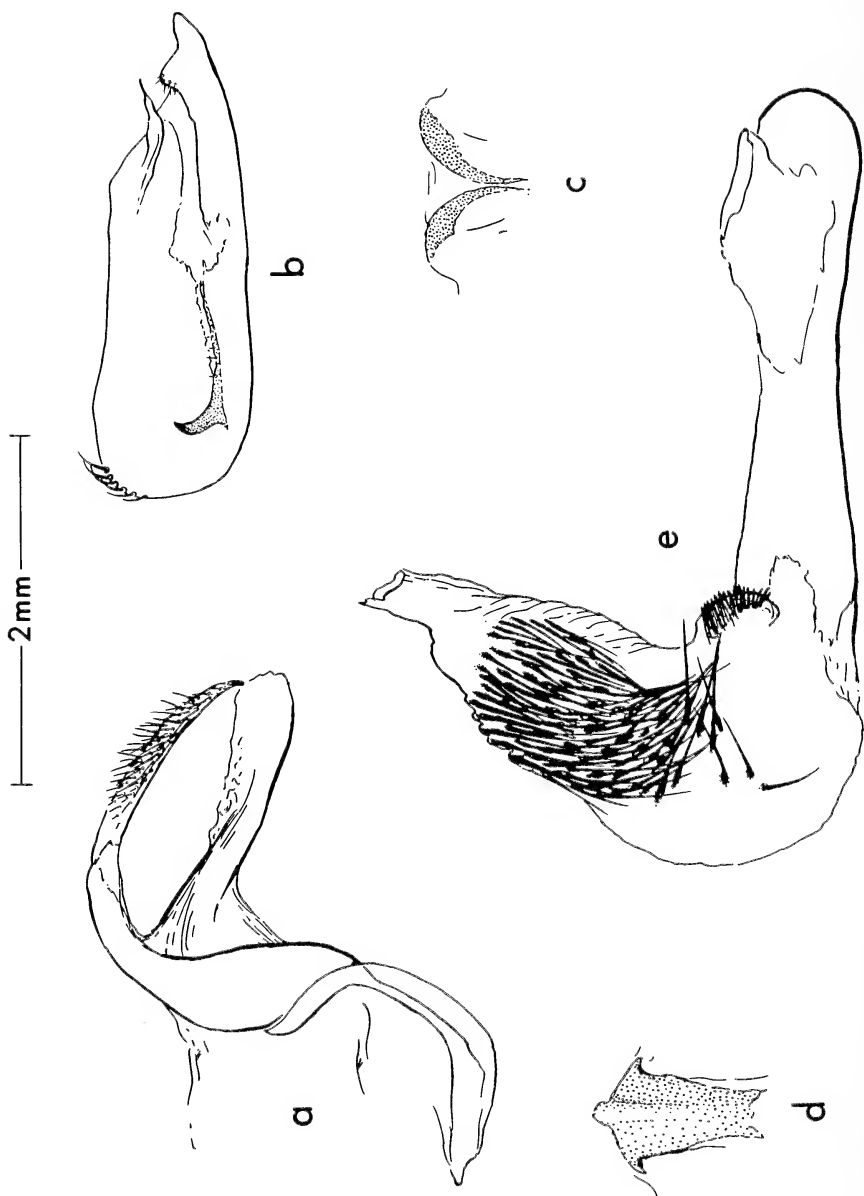


Fig. 2: *Basilodes blanchardi*, n. sp., male genital structures: (a) lateral view of tegumen, vinculum, uncus etc., (b) inner view of valve, (c) anellus, (d) juxta and (e) inflated penis.

Upper surface of hind wing white, diffusing to light-brown distally; fringe white-tipped.

Under surface of fore wing suffuse light-brown, slightly darker in sub-median area.

Under surface of hind wing evenly creamy-white.

Vestiture of head light-yellow, an area of light-brown, white-tipped scales anterior to eye; scape and dorsum of antennae white-scaled; palpal scales grey-brown, white-tipped; thoracic scales very long, spatulate, grey-brown, white-tipped; pleural scales light-yellow; abdomen pale-yellow dorsally, murky grey-brown mid-ventrally.

Frontal protuberance moderately prominent, an inverted heart-shaped ring with a medium-sized ventral convexity.

Adult female. Essentially identical to male except for slightly larger size; fore wing length 15-16 mm. (Fig. 1).

Male and female genitalia: As figured (Figs. 2-3).

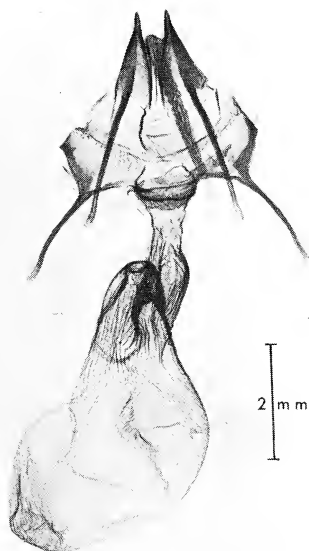


Fig. 3: *Basilodes blanchardi*, n. sp., female genitalia.

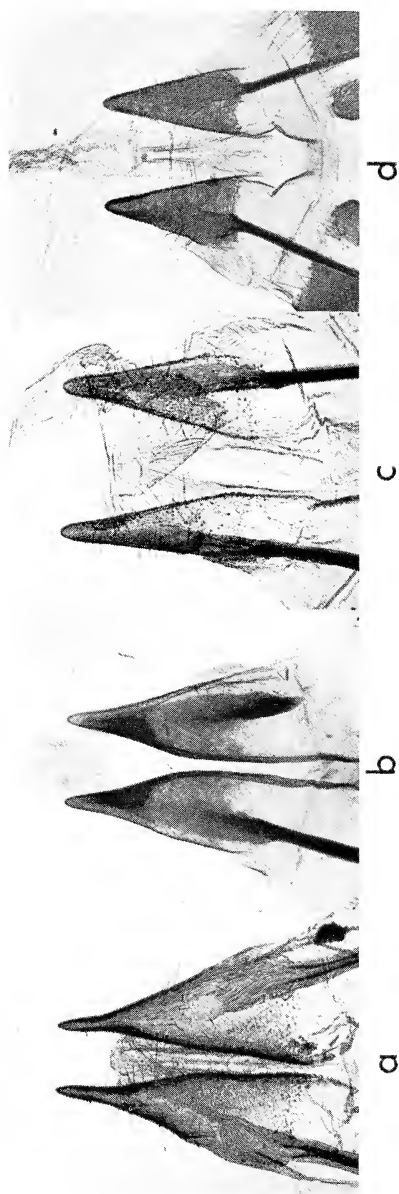


Fig. 4: *Basilodes blanchardi* (a) and related species, *B. rugifrons* (b), *B. sulphureus* (c) and *B. dyari* (d). Comparative anatomy of female ovipositor lobes.

Diagnosis:

Basilodes blanchardi is a member of the *B. rugifrons* group also including *rugifrons* (Grote, 1874), *dyari* (Hill, 1924), *sulphureus* (Neumoegen, 1882), *ruficeps* (Draudt, 1927), *colimae*² (Draudt, 1927), *intermixtus* (Dyar, 1918), and *mouris* (Dyar, 1912). It is readily distinguished superficially by the unique immaculate median field of the upper fore wing surface. The conspicuous hexagonal or quadrate brown spot ("hindmarginal spot" of Draudt) in this area midway along the inner margin usual for all the other above named species is absent.

Due to the lack of material of most of the members of the group (only *rugifrons*, *dyari* and *sulphureus* are represented in collections by more than a few specimens), it is impossible to fully diagnose *blanchardi* in regard to genitalic characters. On the basis of known character states for some of the species, the male genitalia do not present any strong diagnostic features. The group appears to be a complex of closely related forms differing little in the male genitalia. The number and distribution of cornuti on the penis vesica as well as other quantitative characters may be called upon to characterize the species when adequate material becomes available.

The female ovipositor lobes will also probably prove to be unique in regard to shape, distribution of setae, amount of sclerotization, etc. At least this is true when this structure is compared with *rugifrons*, *dyari* and *sulphureus* (Fig. 4).

The *Basilodes rugifrons* group, including *blanchardi*, is decidedly in need of thorough taxonomic revision. Material has to be collected of the rare Mexican species and all species should be reared. Analysis of the geography and morphology of the group will probably reveal the need for some new synonymies and segregation of geographic subspecies (Hogue, 1963:78).

MATERIAL:

Holotype. ♂ : Carlsbad Caverns N.P., Eddy County, New Mexico. 17 September 1963 (A. & M.E. Blanchard) [L.A.C.M.].

Allotype. ♀ : White's City, Eddy County, New Mexico. 17 September 1963 (A. & M.E. Blanchard); with genitalia slide No.: CLH 641117-2 [L.A.C.M.].

Paratypes. 3 ♂ ♂ : Same locale and collectors as holotype. 17-18 September 1963; one with genitalia slide No.: CLH 640225-1. 1 ♂ : Oak Spring, Big Bend N.P., Brewster County, Texas. 31 August 1964 (A. & M.E. Blanchard); with genitalia slide No.: CLH 641117-1. 1 ♀ : Basin, Big Bend N.P., Brewster County, Texas. 4 September 1964 (A. & M.E. Blanchard). 1 ♀ : Shelter Cave, Organ Mountains, Dona Ana County, New Mexico. 1 September 1930; with genitalia slide No.: CLH 640225-2. [L.A.C.M., A. Blanchard, U.S.N.M., A.M.N.H.].

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1. Mr. Blanchard has also sent a specimen of another *Basilodes* worth mentioning here as it represents a new record for the United States.
Basilodes inquinatus Hogue, 1963. 1 : Welder Wildlife Foundation, 8 mi. NE Sinton, San Patricio County, Texas. 1 October 1964 (A. & M.E. Blanchard) [L.A.C.M.].
The species was formerly known only from Mexico.
2. I take this opportunity to correct an error in my recent paper on the Stiriini (Hogue, 1963:78) concerning this species. My statement, "Judging from the figure accompanying the original description, I guess that this species may be at most a variation or subspecies of the preceding species.", is impossible since there is, in fact, no illustration of *colimae* on plate 45, row b as stated the text. The species does seem to belong in the position I have given judging from the description.

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REDISCOVERY AND REDESCRIPTION OF THE MOTH *LITHOPHANE VANDUZEEI* (BARNES),

WITH NOTES ON THE TYPE LOCALITY
(LEPIDOPTERA: NOCTUIDAE).

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and

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IN RECENT YEARS SPECIMENS OF *Lithophane vanduzeei* (Barnes) have been collected at the type locality, Carmel, Monterey County, California. This species was described from two specimens collected by L. S. Slevin in the winter of 1926 and 1927, and until recently, the species was known from only the holotype, one paratype and an additional specimen. The holotype and one additional specimen are contained in the California Academy of Sciences, San Francisco, and the single paratype was retained by Barnes at the time of the original description and is now contained in the collection of the United States National Museum.

In the original description, Barnes indicated the relationship of *vanduzeei* within the genus by stating "Allied to, and should be listed next to, *lepida* Lintner." Benjamin (1935) placed *vanduzeei* as a subspecies of *lepida*, based on his opinion that "The genitalia do not indicate a species distinct from *lepida*." McDunnough (1938) considered *vanduzeei* to be a distinct species and placed it after *nasar* (Smith). Whatever the case, it is clearly beyond the scope of this paper to review this group of species at the present time. It is the authors' present opinion that *vanduzeei* should be considered a distinct species, and until the results of the current study of this group by Franclemont are published, no absolute relationships will be known concerning *vanduzeei* and other closely related species.



Fig. 1 *Lithophane vanduzeei*, male. Carmel, Monterey County, California, 4 April 1965 (R. H. Leuschner).



Fig. 2 *L. vanduzeei*, female. Same locality and collector as preceding, 30 December 1962.

L. vanduzeei, like other species in the genus, has an extended period of emergence, or else exhibits hibernation, some specimens having been collected in December, and others collected as late as April. The type locality is a heavily forested area, the predominant trees being Monterey Pine (*Pinus radiata* Don.), Coast Live Oak (*Quercus agrifolia* Nee), Madrono (*Arbutus menziesii* Pursh.), shrubs, and other low growing plant species. This area like other coastal areas of central California is quite frequently shrouded in fog, and the mean temperature through the winter months is generally in the range of 40°F. to 50°F.

Lithophane vanduzeei (Barnes)

Graptolitha vanduzeei Barnes, 1928. Pan Pacific Ent. 5(1):9.

Topotype male: Ground color of primaries charcoal, secondaries pinkish brown. Head with vertex clothed in black, white forked hairs and spatulate scales, vestiture forming two porrect tufts; area between antennae clothed in short spatulate scales; frons clothed as in vertex but without porrect tufts; palpi clothed in dirty whitish flattened scales and divided hairs; antennae dorsally clothed in silvery-white scales, ventrally fasciculate, or each flagellomere possessing a cluster of hairs; eyes weakly lashed. Thorax with collar tricolor, basally charcoal, preapically black banded, apically silvery-white tipped; disc of ground color, but possessing a few brown scales; anterior tuft divided, composed of elongate scales and forked hairs; posterior tufts weak, colored as in anterior tufts; ventral surface clothed in light grey; legs with tarsi weakly black and white banded; tarsal claws apparently not bifid, tended by stiff bristles; primaries with ordinary lines poorly defined, but distinguishable on some specimens; basal innermarginal region tan; basal half line proximally blackish, distally whitish; black basal dash thin, but prominent; transverse anterior line hardly discernable; transverse anterior area sprinkled with white scales; median shade dark; orbicular rectangular, outlined in black, centrally sprinkled with white; reniform rectangular, constricted medially, colored as in orbicular; prominent black scaling present on Cu₂ from transverse anterior line to transverse posterior line (as in fig. 1); subterminal line represented by blackish scalation; subterminal area silvery with medial veins outlined in black and white; terminal darker than subterminal area; terminal line represented faintly as black lunules between veins; ventral surface basally brownish, grading into grey terminally; reniform dark brown; secondaries dorsally

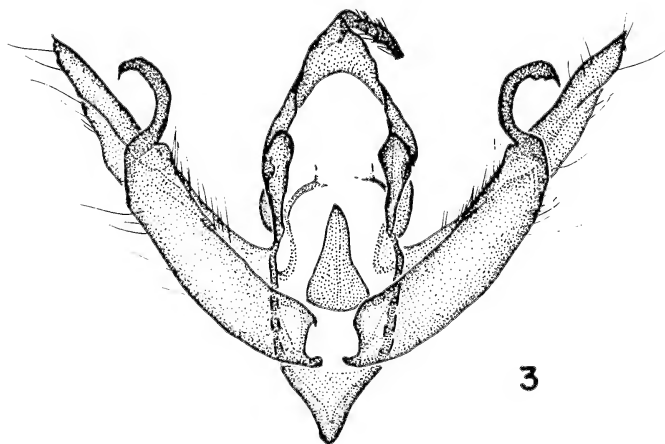


Fig. 3 *L. vanduzeei*, male genitalia minus aedeagus. Same data as in fig. 1 (Bauer-Buckett slide No. 66D11-1).

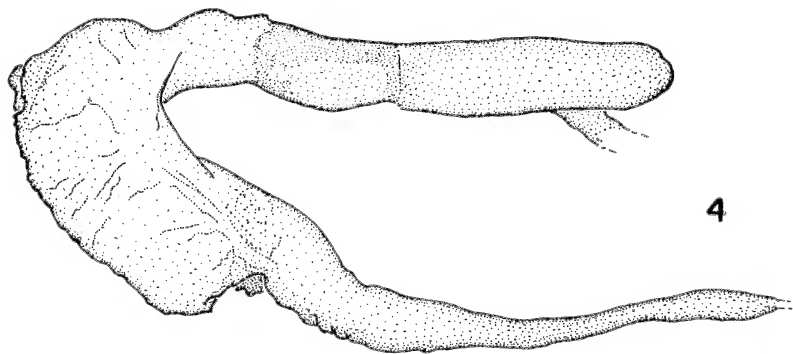


Fig. 4 *L. vanduzeei*, inflated aedeagus of male genitalia. Same data as preceding.



Fig. 5 *L. vanduzeei*, female genitalia. Same data as in fig. 2 (Bauer-Buckett slide No. 66D11-2).

glossy, pinkish-brown; veins faintly outlined in dark brown; fringes lighter than rest of wing; ventral surface lighter than dorsal surface; discal mark more prominent; exterior line faint, represented in dark brown. Abdomen dorsally clothed in pinkish and brown scales and hairs, terminal-laterally clothed in fawn brown simple hairs; ventrally appearing pinker than dorsal surface. Greatest expanse of forewing 19 mm. Genitalia as in figs. 3 and 4.

Female: As in male but slightly darker; antennae setose-ciliate; ventral surface of wings brighter than in male; otherwise as in male. Greatest expanse of forewing 20 mm. Genitalia as in fig. 5.

Specimens examined: All specimens collected at Carmel, Monterey County, California. Holotype female (No. 2565, California Academy of Sciences, San Francisco), 27 January 1926 (L. S. Slevin); 1 female, 26 January 1931 (L. S. S.); 2 males, 4 April 1965 (R. H. Leuschner), one with label "Bauer-Buckett slide No. 66D11-1"; 1 female, 30 December 1962 (R. H. L.) with label "Bauer-Buckett slide No. 66D11-2."

We would like to extend our appreciation to Mr. William R. Bauer for the excellent preparation of the genitalia slides. Illustrations were drawn by aid of a bioscope and corrections were made by use of a dissecting microscope. Illustrations were drawn to the same scale, and were prepared by the first author.

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THE REARING OF DIRPHIOPSIS EUMEDIDE (SATURNIIDAE)

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THE LARVAE OF THE DIRPHIA GROUP of the Hemileucini appear to have been rarely reared or described and a number of vague and speculative statements have sometimes been made about them.

As the result of being sent ova from the Neotropical area, it has now been possible to elucidate the life-history of a number of species and the first of these is described in this paper.

Ova of *Dirphiopsis eumedide* Cramer were sent to me by air mail post in 1961, 1962 and 1963. These were obtained by Dr. A. D. Blest while he was stationed in the Canal Zone Biological Area of the Smithsonian Institution in Panama. The ova were laid by females taken at a light-trap during August.

THE OVA — On receipt these were off-white in color with a brownish micropyle of medium size. They measured 1.0 x 1.5 x 1.75 mm high. They had been laid in rather irregular batches, firmly affixed to the substratum by a brownish cement. Some of the batches were scattered with hairs from the female abdomen. It seems likely that this was accidental, due to the confined conditions under which they were laid.

Some of the batches received were wholly infertile. Of the others, only about 50 per cent hatched except for 1963 when the hatch was 90 per cent. The unhatched ova were about equally divided between infertility and simple failure of the larvae to eat their way out.

On receipt the eggs were kept at 25°C. Allowing for a 4 day period of transit, the minimum time taken to hatch by four batches was 17, 19, 13, and 18 days. Since these had been laid a few days before dispatch it is a safe assumption that the normal time taken to hatch of *D. eumedide* ova is about three weeks. There is no darkening or other apparent change in the ova immediately prior to hatching.

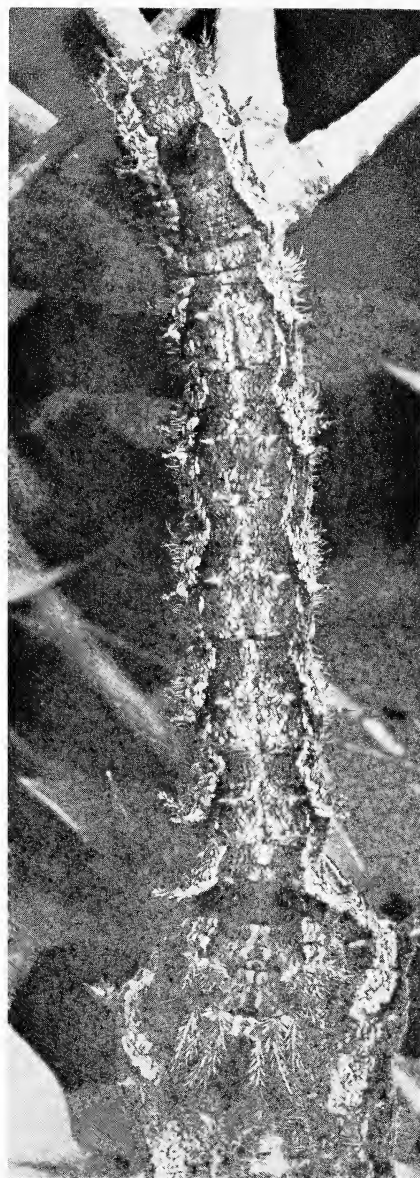


Fig. 1. Fullgrown larva of *Dirphlopsis eumedide* at rest on twig.

THE LARVAE — When newly hatched, the larvae have a pale shiny-brown head with a very fine black \wedge mark above the jaws. The body light brown; chalazae paler brown, almost translucent, bearing long black spines. No descriptions were kept of intermediate instars due to lack of time. From the second to final instar, however, there is little change in general color or patterning. The fully-grown larva is 5-6 cms long. The ground color a brownish-red, mottled with olive-brown and pinkish-brown, darker laterally. There is some variation in shade between individual larvae. The patterning is broken up to give the effect of broad zig-zag lines. The whole surface is covered by a net-like tracery of fine black hairs. Spiracles pink and finely outlined with black. Between segments 1-2 and 2-3 there are paired black areas on the intersegmental membranes and these are only exposed to view when the larvae curl up. These 'lappets' doubtless perform the same function as do those on the better known larvae of certain Lasiocampidae and have evolved independently to serve the same purpose of scaring off would-be predators. The chalazae on segments 1, 2, fairly long, overlap the head, densely clothed with short spines. On segments 3, 4, the dorsal chalazae are shorter but also very densely spined; laterally shorter and bearing rather fewer spines. The chalazae on the remaining segments are very short and bear very short spines, slightly longer along the subspiracular line. On abdominal segment 8 there is, however, a large densely spined central chalaza, and on segment 10 a pair of dorsal chalazae, not so large. The chalazae are colored dark reddish-brown and their spines greyish to black. Ventrally the body, including the legs and prolegs, is moderately clothed with short whitish hairs. The head black with a whitish-brown \wedge and similar coloring to sides. (Fig.1).

FOODPLANTS — The natural foodplant of *D. eumedide* being unknown, the first newly hatched larvae to hand were offered a choice of Hawthorn (*Crataegus oxyacantha*), Apple (*Pyrus* sp.), and Plum (*Prunus domestica*). After three days they commenced to feed on the first of these. After the first moult the larvae were offered Beech (*Fagus sylvatica*) and they transferred to this in preference. Elm (*Ulmus campestris*) was also later offered and eaten. Subsequent batches of larvae were started off on either Beech or Elm and these commenced to feed within 24 hours of hatching. Other foods readily eaten were Laburnum (*Laburnum anagyroides*) and Black locust (*Robinia pseudo-*

acacia). Since the larvae were being reared in the fall and early winter, the supply of these deciduous trees gave out before pupation and the larvae mostly completed their development on Evergreen oak (*Quercus ilex*). They did not, however, seem altogether happy with this food and virtually the only losses occurred at this stage. According to Dr. A. D. Blest (personal communication) the resultant moths are small compared to feral Panamanian examples.

INSTARS AND GROWTH RATE — The larvae were kept at 20-25°C. At various times this varied for short periods by about 5°C. above and below these limits. Natural British daylight conditions from September to December were experienced by the larvae although they frequently had an extra hour or two of artificial light during the evenings. Under these conditions all the larvae had seven instars. As seems usual with gregarious larvae the moults take place in unison and it is not until the penultimate instar that a noticeable scatter of some 3 days begins to occur. In the final instar, however, the scatter varied from 20-45 days. It should, however, be borne in mind that the slower developers had to spend more time on the not-altogether satisfactory food, Evergreen oak, which doubtless caused some extension of feeding time than would otherwise have taken place had it been possible to continue feeding on Elm. The mean instar times in days, based on several batches and over 200 larvae were as follows: — 1st — 8; 2nd — 9; 3rd — 7; 4th — 8; 5th — 12; 6th — 13; 7th — 32; Total 89. This is a long feeding period for a Saturniid, being exceeded only by *Euleucophaeus rubridorsa* Felder (Gardiner, 1966), and is at least one third longer than other *Dirphia* group species known to me and from which it differs morphologically (Gardiner, *in preparation*; Gardiner 1963).

LARVAL HABITS — The larvae are gregarious. They feed by night and cluster during the day. In the later instars they come down off the foodplant and form a rather loose cluster around the stems of the cut foliage which were placed in a bottle of water. When in this position they bear a remarkable resemblance to the stems and, in spite of the fact that the spines on the chалазae can inflict a reasonably painful sting, are clearly cryptically marked. They are rather slow-moving and lethargic and do not, except in the first instar, show any tendency to walk in single file.

PUPATION — The larvae leave the foodplant to pupate. In their cages they formed a tough fibrous cocoon just below the surface of a layer of peat which was overlain by a quantity of loose dried moss. A few cocoons were formed in the moss itself. The majority of the pupae were used in physiological experiments and only 5 were retained. From these moths emerged after about two months.

DISCUSSION — Under the conditions of rearing *D. eumedide* had a life period of six months which would make it a normally double-brooded species. Due to the scatter in the eclosion period of the few pupae retained, it was unfortunately not possible to obtain pairings.

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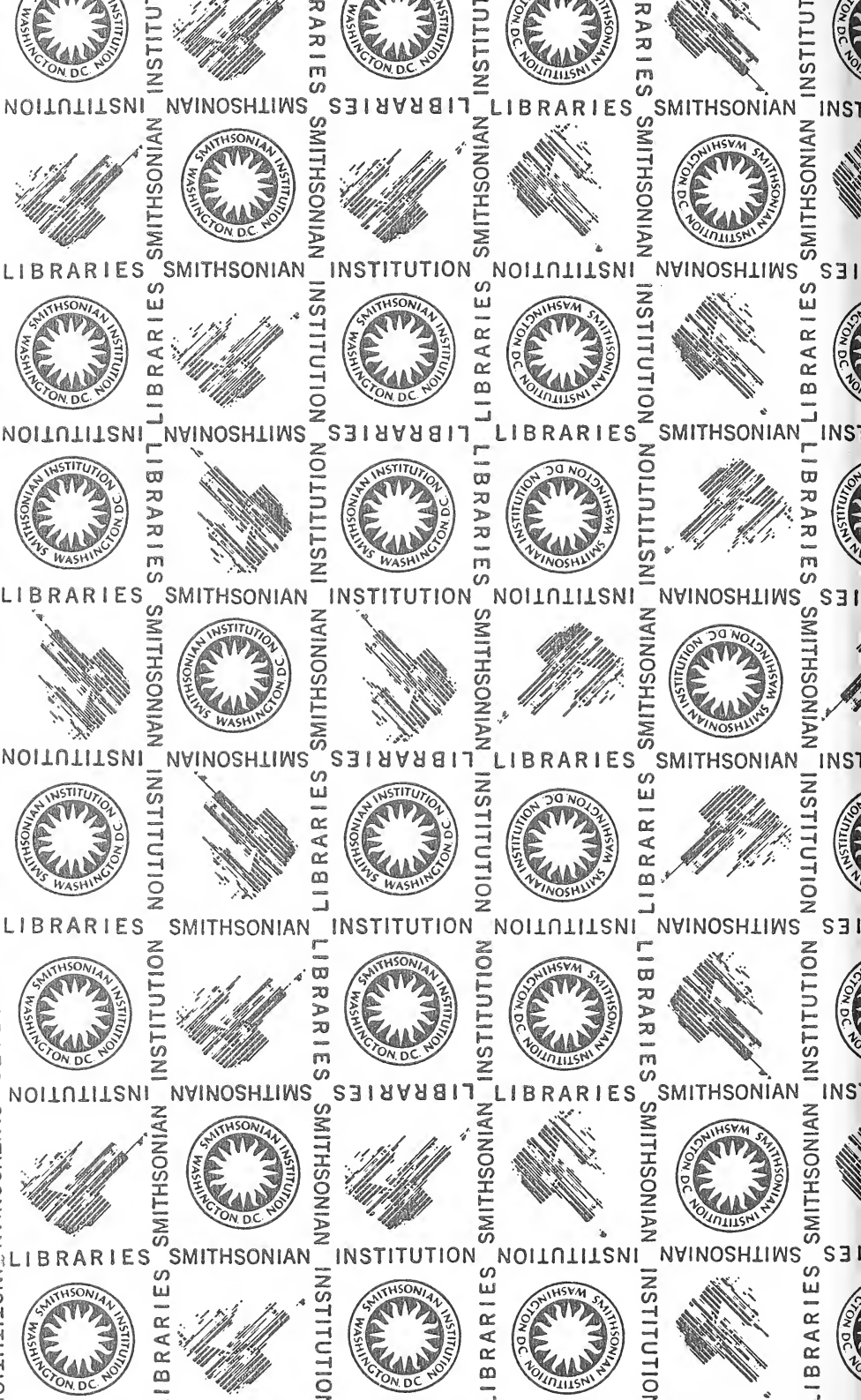
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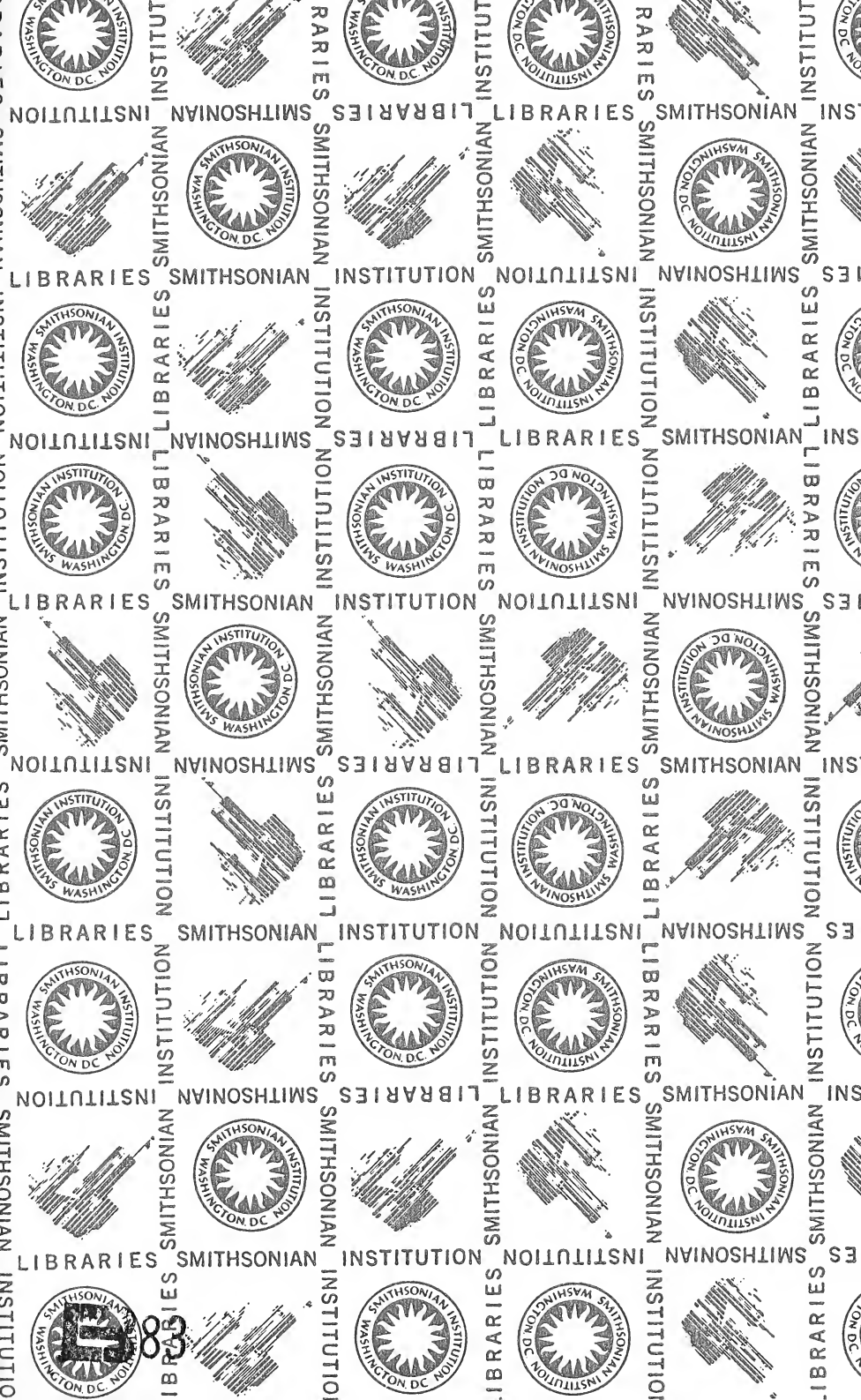
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